

CCA Finance Data

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Minimum variance portfolio rebalancing

The minimum variance portfolio selection problem is defined as follows. Given p risky assets, let r_{it} denote the return of asset i over period t ; which in turn is defined as the change in its price over time period t , divided by the price at the beginning of the period. As usual, let Σ_t denote the covariance matrix of the daily returns, $r_t^T = (r_{1t}, r_{2t}, \dots, r_{pt})$. The portfolio weights $w_k^T = (w_{1k}, w_{2k}, \dots, w_{pk})$ denote the weight of asset $i = 1, \dots, p$ in the portfolio for the k -th time period. A long position or a short position for asset i during period k is given by the sign of w_{ik} , i.e., $w_{ik} > 0$ for long, and $w_{ik} < 0$ for short positions respectively. The budget constraint can be written as $\mathbf{1}^T w_k = 1$, where $\mathbf{1}$ denotes the vector of all ones. Note that the risk of a given portfolio as measured by the standard deviation of its return is simply $(w_k^T \Sigma w_k)^{1/2}$. The minimum variance portfolio selection problem for investment period k can now be formally defined as follows:

$$\min w_k^T \Sigma w_k \text{ subject to } \mathbf{1}^T w_k = 1$$

As this is a simple quadratic program, it has a simple analytic solution $w_k^* = (\mathbf{1}^T \Sigma^{-1} \mathbf{1})^{-1} \Sigma^{-1} \mathbf{1}$. The most basic approach to the portfolio selection problem often makes the unrealistic assumption that returns are stationary in time. A standard approach to dealing with the non-stationarity in such financial time series is to use a periodic rebalancing strategy. In particular, at the beginning of each investment period $k = 1, 2, \dots, K$, portfolio weights $w_k^T = (w_{1k}, w_{2k}, \dots, w_{pk})$ are computed from the previous N_{est} days of observed returns (N_{est} is called the “estimation horizon”). These portfolio weights are then held constant for the duration of each investment period. The process is repeated at the start of the next investment period and is often referred to as “rebalancing.”

We now consider the problem of investing in the stocks that feature in the S&P 500 index. The S&P 500 is a composite blue chip index consisting of 500 stocks. (note that a number of stocks were removed in our analysis due to its limited data span - in the end we used 398 stocks).

Rebalancing time points were chosen to be every 64 weeks starting from 2000/01/01 to 2016/12/31 (approximately 17 years). Start and end dates of each period are selected to be calendar weeks, and need not coincide with a trading day. The total number of investment periods is 14, and the number of trading days in each investment period is approximately 320 days. We shall compare the following three methods for estimating the covariance matrix: sample covariance, IPF and CCA. We consider various choices of N_{est} , in particular, $N_{est} \in \{375, 450, 525\}$ in our analysis. Note that once a choice for N_{est} is made, it is kept constant for all the 14 investment periods.

Note that for IPF and CCA we need to pick a graph for the concentration matrix. When N_{est} is less than 398, we threshold the generalized inverse for the sample covariance and when N_{est} is larger than 398, we threshold the inverse till we achieve a sparsity of approximately 95%.

Table gives the realized Sharpe ratios of all MVR strategies for the different choices of estimation horizon N_{est} . The column SP500 stands for the passive index tracking strategy that tracks the S & P 500 average index. We can see that CCA performed the best in terms of Sharpe ratios when $N_{est} = 375, 405$ and almost as well as IPF when $N_{est} = 525$. Both of these methods are superior to the sample covariance and the S&P500 index.

Figure shows that in terms of Normalized Wealth Growth CCA performs the best as well. IPF is a close second, while the sample covariance and the S & P 500 index lag behind.

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MMM.Close ABT.Close ABBV.Close ACN.Close ATVI.Close AYI.Close

	Sample	CCA	IPF	SP500
375	0.000	0.482	0.471	0.132
450	0.329	0.479	0.463	0.132
525	0.118	0.473	0.475	0.132

Table 1: Realized Sharpe ratio of different investment strategies corresponding to different estimators with various N_{est} . The maximum annualized Sharpe ratios for each row

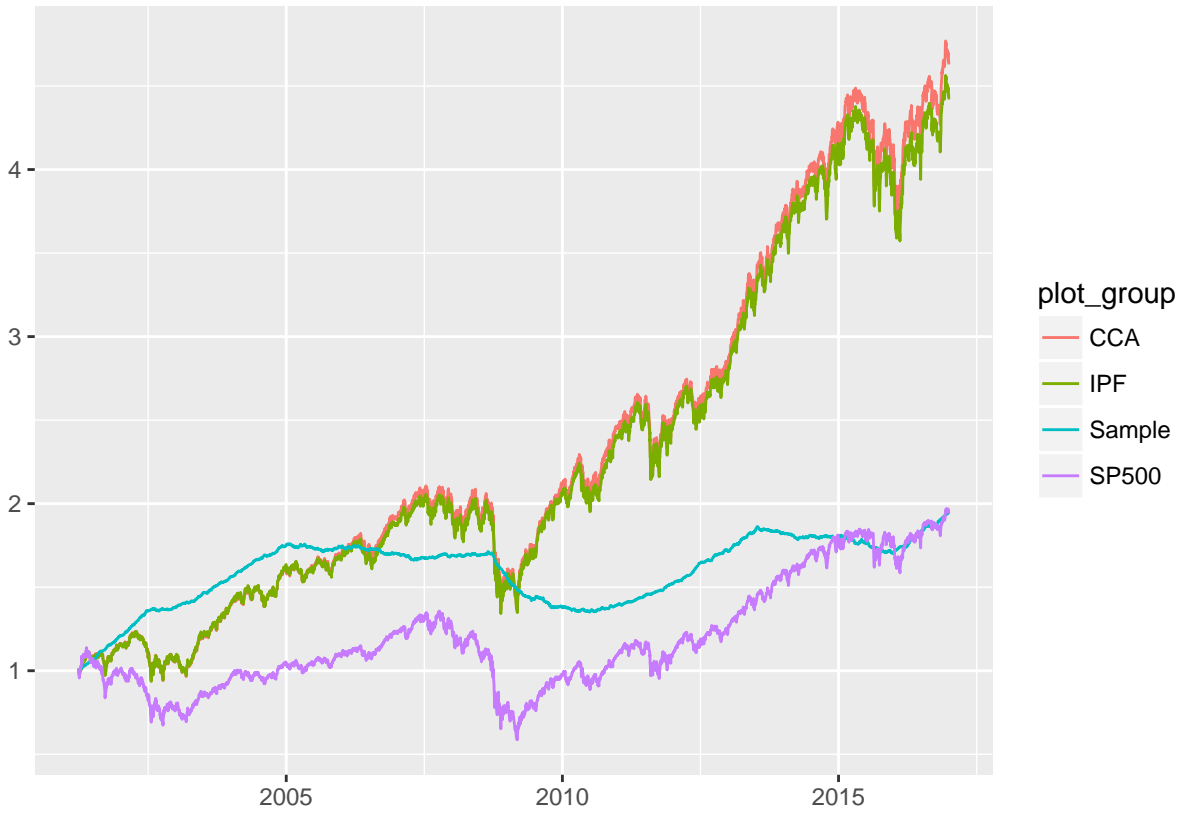


Figure 1: Normalized wealth growth after adjusting for transaction costs (0.5% of principal) and borrowing costs (interest rate of 8% APR) with $N_{est} = 450$

##	2000-01-03	94.375	34.99995	NA	NA	16.4375	NA
##	2000-01-04	90.625	33.99995	NA	NA	15.9375	NA
##	2000-01-05	93.250	33.93745	NA	NA	16.0000	NA
##	2000-01-06	100.750	35.12495	NA	NA	15.6875	NA
##	2000-01-07	102.750	35.49995	NA	NA	16.1250	NA
##	2000-01-10	102.250	35.24995	NA	NA	16.9375	NA
##		ADBE.Close	AAP.Close	AES.Close	AET.Close	AMG.Close	AFL.Close
##	2000-01-03	65.5625	NA	72.5000	55.5625	36.7500	44.7500
##	2000-01-04	60.0625	NA	69.6250	54.6250	33.8125	43.5625
##	2000-01-05	61.2500	NA	70.3750	54.2500	33.0000	43.3125
##	2000-01-06	61.7500	NA	70.9375	54.3125	34.0000	44.1875
##	2000-01-07	64.7500	NA	72.3125	57.8750	34.8125	45.0625
##	2000-01-10	67.2500	NA	75.5625	56.8125	35.6875	42.3750
##		A.Close	APD.Close	AKAM.Close	ALK.Close	ALB.Close	ALXN.Close
##	2000-01-03	72.0000	32.8125	321.250	35.0000	18.0000	29.500
##	2000-01-04	66.5000	31.8125	300.000	34.5625	18.0000	27.750
##	2000-01-05	62.3750	32.0000	283.500	34.7500	18.3125	29.125
##	2000-01-06	60.0000	34.1250	236.125	34.7812	18.9375	31.000
##	2000-01-07	65.0000	36.5000	248.375	36.0625	18.6250	33.000
##	2000-01-10	68.9375	34.2500	285.500	35.4375	18.5625	33.125
##		ALLE.Close	AGN.Close	ADS.Close	LNT.Close	ALL.Close	GOOGL.Close
##	2000-01-03	NA	35.0000	NA	26.8125	23.5000	NA
##	2000-01-04	NA	33.8750	NA	26.8125	22.7500	NA
##	2000-01-05	NA	34.5000	NA	28.1250	23.7500	NA
##	2000-01-06	NA	35.0000	NA	28.1250	23.6250	NA
##	2000-01-07	NA	37.4375	NA	28.5000	24.5000	NA
##	2000-01-10	NA	38.8125	NA	28.5625	23.9375	NA
##		GOOG.Close	MO.Close	AMZN.Close	AEE.Close	AAL.Close	AEP.Close
##	2000-01-03	NA	23.4375	89.3750	32.3125	NA	31.4375
##	2000-01-04	NA	23.6250	81.9375	32.3125	NA	31.8125
##	2000-01-05	NA	23.5000	69.7500	33.5625	NA	33.0000
##	2000-01-06	NA	23.0625	65.5625	33.4375	NA	33.1875
##	2000-01-07	NA	23.6875	69.5625	33.9375	NA	33.6250
##	2000-01-10	NA	24.0000	69.1875	33.6875	NA	33.5000
##		AXP.Close	AIG.Close	AMT.Close	AWK.Close	AMP.Close	ABC.Close
##	2000-01-03	157.2502	103.93751	29.3125	NA	NA	15.5625
##	2000-01-04	151.3127	98.62500	29.0000	NA	NA	14.5000
##	2000-01-05	147.2502	98.85931	29.8750	NA	NA	15.6250
##	2000-01-06	150.2502	101.87501	29.5625	NA	NA	16.8125
##	2000-01-07	152.4377	109.50000	31.1875	NA	NA	19.0000
##	2000-01-10	154.5627	107.56250	33.9375	NA	NA	19.5000
##		AME.Close	AMGN.Close	APH.Close	APC.Close	ADI.Close	ANTM.Close
##	2000-01-03	19.0000	62.9375	67.2500	32.6875	90.1875	NA
##	2000-01-04	18.9375	58.1250	64.9375	32.7500	85.6250	NA
##	2000-01-05	19.1250	60.1250	63.5000	33.2500	86.8750	NA
##	2000-01-06	19.0000	61.1250	61.7500	33.8125	84.5000	NA
##	2000-01-07	19.2500	68.0000	62.3750	34.6250	86.8750	NA
##	2000-01-10	19.8750	72.1250	65.3125	33.6875	94.4375	NA
##		AON.Close	APA.Close	AIV.Close	AAPL.Close	AMAT.Close	ADM.Close
##	2000-01-03	39.000	34.1250	38.0000	111.9375	126.5000	12.0000
##	2000-01-04	38.125	32.6250	37.5000	102.5000	120.2500	11.8750
##	2000-01-05	39.250	33.5625	37.8750	104.0000	115.7500	11.6875
##	2000-01-06	40.625	36.7500	38.6250	95.0000	115.9375	11.7500
##	2000-01-07	42.750	36.6250	39.0625	99.5000	116.9375	11.9375

##	2000-01-10	30.125	35.1875	39.6875	97.7500	126.3750	11.9375
##		ARNC.Close	AJG.Close	AIZ.Close	T.Close	ADSK.Close	ADP.Close
##	2000-01-03	80.93747	63.6250	NA	47.0000	33.3750	51.99991
##	2000-01-04	81.31247	60.7500	NA	44.2500	31.7500	51.99991
##	2000-01-05	85.99997	61.0000	NA	44.9375	29.7500	51.49991
##	2000-01-06	84.87497	60.8906	NA	43.7500	27.9375	52.18741
##	2000-01-07	84.62497	63.2500	NA	44.1250	31.2500	53.37491
##	2000-01-10	84.37497	60.9375	NA	44.7500	30.8750	54.68741
##		AN.Close	AZO.Close	AVB.Close	AVY.Close	BHI.Close	BLL.Close
##	2000-01-03	9.0625	30.5625	33.9375	71.3750	20.2500	39.8125
##	2000-01-04	8.6875	30.4375	33.1875	70.4375	20.2500	38.5000
##	2000-01-05	8.6250	30.3125	33.5000	72.7500	20.3750	39.1875
##	2000-01-06	8.6250	29.0625	34.6250	75.3125	22.3125	39.8125
##	2000-01-07	8.9375	30.4375	35.5000	75.5625	23.8125	38.6875
##	2000-01-10	8.8750	30.6875	35.9375	78.0000	23.0625	39.9375
##		BAC.Close	BCR.Close	BAX.Close	BBT.Close	BDX.Close	BBBY.Close
##	2000-01-03	48.4375	50.9375	61.3750	25.8125	26.1875	33.0000
##	2000-01-04	45.5625	50.3750	60.0000	25.0625	25.5000	30.9375
##	2000-01-05	46.0625	52.1875	62.6250	25.3750	25.6875	31.3750
##	2000-01-06	50.0000	53.3125	63.9375	26.5625	26.7500	32.1250
##	2000-01-07	48.6875	54.6875	67.5625	26.7500	28.2500	33.5625
##	2000-01-10	47.0000	53.8125	65.0000	26.0625	27.6250	35.2500
##		BBY.Close	BIIB.Close	BLK.Close	HRB.Close	BA.Close	BWA.Close
##	2000-01-03	57.750	93.2500	16.625	41.8125	40.1875	38.6875
##	2000-01-04	57.375	86.9375	15.875	40.6875	40.1250	38.6875
##	2000-01-05	57.000	93.0000	15.750	44.5000	42.6250	38.8750
##	2000-01-06	56.500	97.1250	16.000	44.0625	43.0625	38.3750
##	2000-01-07	58.250	108.3125	15.875	45.5625	44.3125	39.4375
##	2000-01-10	57.625	119.5000	16.000	45.1875	43.6875	39.0000
##		BXP.Close	BSX.Close	BMJ.Close	AVGO.Close	CHRW.Close	CA.Close
##	2000-01-03	30.6875	23.0000	64.43773	NA	39.1250	70.0000
##	2000-01-04	30.1875	23.3750	59.56271	NA	37.8125	70.0000
##	2000-01-05	30.4375	25.0625	58.93771	NA	37.3125	63.0000
##	2000-01-06	31.0000	25.7500	59.75021	NA	37.5000	59.0000
##	2000-01-07	32.1250	24.8125	68.50024	NA	38.0000	58.7500
##	2000-01-10	32.3750	24.0000	67.75025	NA	39.6875	62.6875
##		COG.Close	CPB.Close	COF.Close	CAH.Close	KMX.Close	CCL.Close
##	2000-01-03	14.8125	37.2500	46.1875	49.3125	2.2500	46.8750
##	2000-01-04	14.3750	35.8750	43.3125	48.7500	2.1875	46.3125
##	2000-01-05	14.6250	35.5625	42.3125	52.1875	2.1250	47.8750
##	2000-01-06	14.9375	36.3125	44.2500	54.0000	2.2500	48.5625
##	2000-01-07	15.5625	37.0000	45.5000	58.8750	2.3750	48.0000
##	2000-01-10	15.0000	35.8125	44.9375	56.0000	2.4375	50.1250
##		CAT.Close	CBOE.Close	CBG.Close	CBS.Close	CELG.Close	CNC.Close
##	2000-01-03	48.6250	NA	NA	NA	67.6875	NA
##	2000-01-04	48.0000	NA	NA	NA	62.2500	NA
##	2000-01-05	49.1250	NA	NA	NA	62.8750	NA
##	2000-01-06	51.6250	NA	NA	NA	61.5000	NA
##	2000-01-07	53.3125	NA	NA	NA	61.0000	NA
##	2000-01-10	51.5625	NA	NA	NA	61.1250	NA
##		CNP.Close	CTL.Close	CERN.Close	CF.Close	SCHW.Close	CHTR.Close
##	2000-01-03	22.2500	45.2500	20.4375	NA	37.000	NA
##	2000-01-04	22.5000	43.4375	20.0625	NA	36.500	NA
##	2000-01-05	23.4375	43.7500	20.0625	NA	36.750	NA

##	2000-01-06	23.5625	43.2500	19.9375	NA	36.750	NA
##	2000-01-07	23.9375	42.8750	20.3125	NA	38.875	NA
##	2000-01-10	23.6250	44.1250	21.0000	NA	39.000	NA
##		CHK.Close	CVX.Close	CMG.Close	CB.Close	CHD.Close	CI.Close
##	2000-01-03	2.2500	83.6250	NA	16.3125	26.000	78.4375
##	2000-01-04	2.0625	83.6250	NA	16.1875	25.375	78.1250
##	2000-01-05	2.0625	85.1250	NA	15.2500	25.375	77.8125
##	2000-01-06	2.1250	88.7500	NA	16.0625	26.250	81.5625
##	2000-01-07	2.0625	90.3125	NA	18.1250	27.250	85.1250
##	2000-01-10	2.1250	87.8750	NA	18.6875	26.875	84.6250
##		XEC.Close	CINF.Close	CTAS.Close	CSCO.Close	C.Close	CFG.Close
##	2000-01-03	NA	30.5312	52.2500	108.0625	52.99987	NA
##	2000-01-04	NA	30.5000	50.1250	102.0000	49.74988	NA
##	2000-01-05	NA	30.8125	50.6875	101.6875	51.74987	NA
##	2000-01-06	NA	31.0000	50.9687	100.0000	54.24986	NA
##	2000-01-07	NA	31.6250	53.5312	105.8750	53.99986	NA
##	2000-01-10	NA	30.7500	54.7500	109.8125	53.81236	NA
##		CTXS.Close	CME.Close	CMS.Close	COH.Close	KO.Close	CTSH.Close
##	2000-01-03	128.1250	NA	29.5000	NA	56.3750	96.0000
##	2000-01-04	121.8125	NA	29.8750	NA	56.4375	92.7500
##	2000-01-05	114.8125	NA	30.6875	NA	56.9375	97.8750
##	2000-01-06	105.0000	NA	30.4375	NA	57.0000	92.8750
##	2000-01-07	111.6250	NA	31.1250	NA	60.7500	94.0000
##	2000-01-10	124.3125	NA	30.6875	NA	58.8125	95.8125
##		CL.Close	CMCSA.Close	CMA.Close	CAG.Close	CXO.Close	COP.Close
##	2000-01-03	62.2500	46.7500	45.0000	22.8750	NA	45.31247
##	2000-01-04	60.6250	43.2500	43.1250	22.4375	NA	44.43747
##	2000-01-05	58.5625	42.1250	43.0000	22.0625	NA	43.62497
##	2000-01-06	58.4375	43.7500	44.2500	22.6875	NA	45.12497
##	2000-01-07	61.9375	42.3750	44.1875	23.1875	NA	45.12497
##	2000-01-10	63.6250	47.8125	42.7500	23.0000	NA	44.99997
##		ED.Close	STZ.Close	GLW.Close	COST.Close	COTY.Close	CCI.Close
##	2000-01-03	33.7500	49.8125	121.8125	89.0000	NA	30.5312
##	2000-01-04	34.1875	47.9375	110.0000	84.1250	NA	30.5000
##	2000-01-05	35.7500	49.5625	107.5000	85.5625	NA	30.0625
##	2000-01-06	35.8125	51.5000	105.0000	87.2812	NA	29.0000
##	2000-01-07	36.0625	53.0000	116.8750	93.0625	NA	30.5000
##	2000-01-10	35.1250	51.0000	118.0000	95.0000	NA	31.9375
##		CSRA.Close	CSX.Close	CMI.Close	CVS.Close	DHI.Close	DHR.Close
##	2000-01-03	NA	30.9375	47.3125	37.8125	13.2500	46.5000
##	2000-01-04	NA	30.0000	46.0000	37.5000	12.7500	44.8125
##	2000-01-05	NA	30.6250	46.0625	39.5625	12.9375	45.3125
##	2000-01-06	NA	32.0000	47.6875	36.7500	12.2500	45.8125
##	2000-01-07	NA	32.0000	48.9375	37.6250	12.6875	46.1875
##	2000-01-10	NA	32.0000	49.6250	37.5625	12.9375	47.1250
##		DRI.Close	DVA.Close	DE.Close	DLPH.Close	DAL.Close	XRAY.Close
##	2000-01-03	17.3125	6.8750	42.8750	NA	NA	23.5000
##	2000-01-04	17.1875	6.7500	42.8125	NA	NA	23.5000
##	2000-01-05	17.8125	6.1875	43.8125	NA	NA	23.9062
##	2000-01-06	17.6250	6.0000	46.0625	NA	NA	23.9375
##	2000-01-07	17.3750	6.6250	46.0000	NA	NA	23.8750
##	2000-01-10	17.5000	6.7500	46.9375	NA	NA	24.4375
##		DVN.Close	DLR.Close	DFS.Close	DISCA.Close	DISCK.Close	DG.Close
##	2000-01-03	32.3750	NA	NA	NA	NA	NA

##	2000-01-04	31.6875	NA	NA	NA	NA	NA
##	2000-01-05	32.2500	NA	NA	NA	NA	NA
##	2000-01-06	33.8750	NA	NA	NA	NA	NA
##	2000-01-07	34.0625	NA	NA	NA	NA	NA
##	2000-01-10	33.6250	NA	NA	NA	NA	NA
##		DLTR.Close	D.Close	DOV.Close	DOW.Close	DPS.Close	DTE.Close
##	2000-01-03	48.8750	38.1250	43.8750	132.6250	NA	30.0625
##	2000-01-04	48.8125	39.0625	43.0625	129.0000	NA	30.1250
##	2000-01-05	48.8750	40.1250	43.2500	133.1875	NA	31.0625
##	2000-01-06	49.7500	40.5625	43.4375	136.9375	NA	30.9375
##	2000-01-07	51.5625	40.5625	44.6250	140.0000	NA	31.2500
##	2000-01-10	53.5000	40.5625	45.5625	136.4375	NA	31.4375
##		DD.Close	DUK.Close	DNB.Close	ETFC.Close	EMN.Close	ETN.Close
##	2000-01-03	65.00000	48.25003	28.8125	28.0625	46.4375	71.37503
##	2000-01-04	65.00000	49.00003	27.8750	27.3125	45.3125	68.93753
##	2000-01-05	67.93750	51.00003	27.3750	26.1250	47.5625	69.50003
##	2000-01-06	71.50000	52.37503	27.5000	26.3750	50.5625	70.93753
##	2000-01-07	71.62500	53.75003	28.1250	26.6875	50.4375	73.12503
##	2000-01-10	69.99999	53.68753	28.1875	28.0625	48.8750	71.25003
##		EBAY.Close	ECL.Close	EIX.Close	EW.Close	EA.Close	EMR.Close
##	2000-01-03	141.2500	37.6875	25.0625	NA	101.0625	57.5625
##	2000-01-04	128.0000	36.6875	25.3125	NA	89.3750	56.8750
##	2000-01-05	136.5625	38.1250	26.9375	NA	89.3125	57.9375
##	2000-01-06	134.8750	39.8125	26.8750	NA	80.0000	59.5625
##	2000-01-07	134.7500	39.8125	28.0000	NA	82.3750	62.2500
##	2000-01-10	142.2500	40.6250	28.0000	NA	96.1250	59.0000
##		ETR.Close	EVHC.Close	EOG.Close	EQT.Close	EFX.Close	EQIX.Close
##	2000-01-03	25.2500	NA	15.5000	33.5625	22.3750	NA
##	2000-01-04	25.3125	NA	15.5000	34.6875	21.6250	NA
##	2000-01-05	26.3750	NA	15.0625	35.6875	21.3750	NA
##	2000-01-06	25.8750	NA	16.3125	36.1250	21.1250	NA
##	2000-01-07	25.8750	NA	16.1250	36.6875	22.1250	NA
##	2000-01-10	25.7500	NA	16.2500	35.6250	21.9375	NA
##		EQR.Close	ESS.Close	EL.Close	ES.Close	EXC.Close	EXPE.Close
##	2000-01-03	42.1875	33.3125	49.5625	20.6875	33.8750	NA
##	2000-01-04	41.8750	32.9375	48.6875	20.6875	33.6250	NA
##	2000-01-05	42.7500	32.8125	47.0468	20.8125	35.2500	NA
##	2000-01-06	43.1875	33.1250	48.4375	21.0625	35.3125	NA
##	2000-01-07	44.0000	34.2500	50.1250	21.2500	35.3125	NA
##	2000-01-10	44.3125	34.0625	51.7500	21.0625	37.4375	NA
##		EXPD.Close	ESRX.Close	EXR.Close	XOM.Close	FFIV.Close	FB.Close
##	2000-01-03	43.1875	64.0000	NA	78.3125	119.5000	NA
##	2000-01-04	42.4687	62.1250	NA	76.8125	117.9375	NA
##	2000-01-05	42.5937	62.2500	NA	81.0000	110.8125	NA
##	2000-01-06	42.8125	62.1250	NA	85.1875	102.1250	NA
##	2000-01-07	42.4687	62.8750	NA	84.9375	98.6250	NA
##	2000-01-10	43.0937	62.0625	NA	83.7500	102.0625	NA
##		FAST.Close	FRT.Close	FDX.Close	FIS.Close	FITB.Close	FSLR.Close
##	2000-01-03	42.4375	18.8125	42.9375	NA	69.8750	NA
##	2000-01-04	40.0000	18.7500	41.5000	NA	66.9375	NA
##	2000-01-05	41.6875	18.6875	42.4375	NA	65.9375	NA
##	2000-01-06	41.6875	19.2500	47.2500	NA	68.2500	NA
##	2000-01-07	41.6250	20.2500	47.5000	NA	67.8125	NA
##	2000-01-10	40.5625	20.3750	46.5000	NA	66.0312	NA

##		FE.Close	FISV.Close	FLIR.Close	FLS.Close	FLR.Close	FMC.Close
##	2000-01-03	22.0625	38.1250	16.7500	16.4375	NA	55.0000
##	2000-01-04	22.0625	35.5000	15.4375	16.1250	NA	54.3125
##	2000-01-05	22.8750	37.9687	16.2500	16.3750	NA	55.3125
##	2000-01-06	22.9375	36.7812	16.1250	16.4375	NA	55.2500
##	2000-01-07	23.0625	38.1562	16.2500	16.5625	NA	55.1875
##	2000-01-10	23.1250	38.0625	16.5000	16.2500	NA	57.2500
##		FTI.Close	FL.Close	F.Close	FTV.Close	FBHS.Close	BEN.Close
##	2000-01-03	NA	7.0000	52.37503	NA	NA	31.6875
##	2000-01-04	NA	6.8750	50.62503	NA	NA	31.1250
##	2000-01-05	NA	6.8125	50.81253	NA	NA	31.6250
##	2000-01-06	NA	6.9375	50.87503	NA	NA	33.5625
##	2000-01-07	NA	6.6250	54.62504	NA	NA	33.8125
##	2000-01-10	NA	7.0625	53.62504	NA	NA	34.0000
##		FCX.Close	FTR.Close	GPS.Close	GRMN.Close	GD.Close	GE.Close
##	2000-01-03	21.1875	14.0000	43.1250	NA	49.0625	150.0000
##	2000-01-04	20.0000	14.1875	41.5625	NA	51.1250	144.0000
##	2000-01-05	20.7500	14.3125	39.7500	NA	54.6250	143.7500
##	2000-01-06	20.1250	14.1875	44.4375	NA	54.8125	145.6718
##	2000-01-07	19.6250	14.6875	46.5625	NA	56.2500	151.3125
##	2000-01-10	19.7500	14.5625	47.7500	NA	55.7500	151.2500
##		GGP.Close	GIS.Close	GM.Close	GPC.Close	GILD.Close	GPN.Close
##	2000-01-03	27.93751	34.4375	NA	24.0625	56.31264	NA
##	2000-01-04	26.81251	33.8125	NA	23.8125	53.75008	NA
##	2000-01-05	26.99999	33.6250	NA	23.6875	53.31264	NA
##	2000-01-06	27.93751	33.5625	NA	23.6875	56.93760	NA
##	2000-01-07	28.56249	33.6250	NA	25.2500	65.62496	NA
##	2000-01-10	28.56249	32.9375	NA	24.9375	74.18752	NA
##		GS.Close	GT.Close	GWV.Close	HAL.Close	HBI.Close	HOG.Close
##	2000-01-03	88.3125	27.1875	45.9375	38.3125	NA	62.4375
##	2000-01-04	82.7500	27.3750	44.6250	38.5000	NA	61.1875
##	2000-01-05	78.8750	26.5000	45.2500	36.8125	NA	60.7500
##	2000-01-06	82.2500	26.6875	45.0625	38.3125	NA	60.5625
##	2000-01-07	82.5625	27.6875	44.3750	40.6875	NA	60.2500
##	2000-01-10	84.3750	28.0000	46.3125	39.0625	NA	60.5625
##		HAR.Close	HRS.Close	HIG.Close	HAS.Close	HCA.Close	HCP.Close
##	2000-01-03	57.0000	25.93749	45.2500	18.4375	NA	23.9375
##	2000-01-04	56.2500	24.93749	43.7500	17.2500	NA	23.8750
##	2000-01-05	55.7500	24.68751	42.4375	16.4375	NA	24.3125
##	2000-01-06	56.0625	24.50000	42.8125	16.0000	NA	25.1875
##	2000-01-07	57.0000	25.00000	44.8125	16.5625	NA	25.7500
##	2000-01-10	57.3125	25.00000	44.0625	17.3125	NA	25.8750
##		HP.Close	HSIC.Close	HES.Close	HPE.Close	HOLX.Close	HD.Close
##	2000-01-03	20.6250	12.6250	54.50001	NA	6.0000	65.1875
##	2000-01-04	20.0000	12.0000	53.43750	NA	5.6875	61.7500
##	2000-01-05	20.0000	12.7500	53.00001	NA	6.0000	63.0000
##	2000-01-06	21.1875	12.6875	54.12501	NA	5.9375	60.0000
##	2000-01-07	21.6875	13.1250	56.43750	NA	6.1875	63.5000
##	2000-01-10	21.6250	13.9375	55.74999	NA	6.7500	63.1875
##		HON.Close	HRL.Close	HST.Close	HPQ.Close	HUM.Close	HBAN.Close
##	2000-01-03	56.6875	40.2500	8.4375	117.4375	7.5625	22.4375
##	2000-01-04	55.6875	39.6875	8.3750	108.5625	7.6250	21.7500
##	2000-01-05	54.9375	40.3125	8.0625	107.8750	7.8125	21.1875
##	2000-01-06	56.0000	41.0000	8.1875	101.0000	8.1250	21.9375

##	2000-01-07	59.0000	41.3750	8.3125	103.8750	8.7500	22.1250
##	2000-01-10	59.3125	41.1875	8.7500	111.0625	8.3750	21.1875
##		IDXX.Close	ITW.Close	ILMN.Close	INCY.Close	IR.Close	INTC.Close
##	2000-01-03	16.0625	63.8750	NA	89.65624	52.99999	87.0000
##	2000-01-04	14.6250	61.0000	NA	93.25000	51.93749	82.9375
##	2000-01-05	15.0625	61.7500	NA	85.96876	51.87499	83.6250
##	2000-01-06	15.0000	61.3125	NA	83.31250	54.68751	78.7500
##	2000-01-07	15.8125	65.2500	NA	104.37500	57.25000	82.0000
##	2000-01-10	16.3750	66.5000	NA	110.25000	56.06250	85.7500
##		ICE.Close	IBM.Close	IP.Close	IPG.Close	IFF.Close	INTU.Close
##	2000-01-03	NA	116.0000	55.50001	54.3125	35.5625	60.2500
##	2000-01-04	NA	112.0625	54.12500	50.0000	35.1250	60.8750
##	2000-01-05	NA	116.0000	56.00000	48.8750	35.4375	78.4375
##	2000-01-06	NA	114.0000	57.12500	49.0000	36.2500	70.0000
##	2000-01-07	NA	113.5000	58.62500	50.7500	37.3125	73.5625
##	2000-01-10	NA	118.0000	58.50001	52.3125	36.3750	85.1250
##		ISRG.Close	IVZ.Close	IRM.Close	JBHT.Close	JEC.Close	SJM.Close
##	2000-01-03	NA	55.7500	35.68749	13.43752	31.9375	19.125
##	2000-01-04	NA	54.8125	34.56250	12.75000	31.7500	18.875
##	2000-01-05	NA	52.5000	33.43751	12.87500	31.9375	18.750
##	2000-01-06	NA	51.8750	33.12499	13.25000	32.0937	19.125
##	2000-01-07	NA	53.8125	32.99999	13.25000	32.8125	19.250
##	2000-01-10	NA	53.5000	34.68750	12.87500	33.0000	19.000
##		JNJ.Close	JCI.Close	JPM.Close	JNPR.Close	KSU.Close	K.Close
##	2000-01-03	92.1875	37.93750	72.87499	344.000	70.5000	29.8750
##	2000-01-04	88.8125	36.06250	70.87500	328.875	66.8750	28.8125
##	2000-01-05	89.7500	35.50001	70.43749	326.375	64.8125	28.5625
##	2000-01-06	92.5625	35.12501	71.43750	312.000	66.8750	28.8125
##	2000-01-07	96.5000	35.62500	72.75000	324.875	66.8750	29.2500
##	2000-01-10	94.0625	36.75001	71.50001	325.500	70.0000	28.3125
##		KEY.Close	KMB.Close	KIM.Close	KMI.Close	KLAC.Close	KSS.Close
##	2000-01-03	20.7500	63.93749	33.87501	NA	108.5000	68.3750
##	2000-01-04	20.5000	63.37499	33.56250	NA	103.8750	67.5625
##	2000-01-05	20.1250	63.06250	33.75000	NA	98.6875	68.5000
##	2000-01-06	20.8750	64.00000	34.74999	NA	99.4375	70.6875
##	2000-01-07	21.4375	65.87500	35.31249	NA	105.3125	75.5625
##	2000-01-10	20.7500	67.37500	35.87499	NA	116.5625	75.7500
##		KHC.Close	KR.Close	LB.Close	LLL.Close	LH.Close	LRCX.Close
##	2000-01-03	NA	18.9375	40.5625	39.9375	3.6250	112.3750
##	2000-01-04	NA	19.5625	39.7500	39.2500	3.5000	107.5000
##	2000-01-05	NA	19.8750	39.1875	40.0625	3.5000	105.9375
##	2000-01-06	NA	19.1250	38.5625	39.8125	3.4375	105.1875
##	2000-01-07	NA	18.9375	38.8125	39.5000	3.5625	106.7500
##	2000-01-10	NA	18.4375	38.3125	40.0000	3.5000	112.2500
##		LEG.Close	LEN.Close	LUK.Close	LVLTL.Close	LLY.Close	LNC.Close
##	2000-01-03	20.5625	15.9375	21.75001	85.0625	65.5625	39.0625
##	2000-01-04	19.5000	15.8125	21.31251	79.1875	63.5000	37.9375
##	2000-01-05	19.5000	15.8750	21.25000	76.9375	64.3125	36.6250
##	2000-01-06	19.4375	15.8750	21.56250	73.8125	66.1875	37.0000
##	2000-01-07	19.7500	16.1875	22.12500	75.8750	71.0625	37.9375
##	2000-01-10	19.6875	16.3125	21.93749	79.9375	68.1250	38.0000
##		LLTC.Close	LKQ.Close	LMT.Close	L.Close	LOW.Close	LYB.Close
##	2000-01-03	72.0000	NA	20.2500	59.06250	55.75000	NA
##	2000-01-04	74.0000	NA	20.9375	58.68750	52.75000	NA

##	2000-01-05	77.5000	NA	21.0625	58.31250	52.68752	NA
##	2000-01-06	77.7500	NA	21.3750	57.93750	52.56248	NA
##	2000-01-07	82.0000	NA	21.4375	58.87500	53.75000	NA
##	2000-01-10	86.9375	NA	20.6250	58.56252	55.37500	NA
##		MTB.Close	MAC.Close	M.Close	MNK.Close	MRO.Close	MPC.Close
##	2000-01-03	406.5625	20.3125	50.3750	NA	24.24998	NA
##	2000-01-04	393.5000	19.9375	48.9375	NA	23.31248	NA
##	2000-01-05	395.2500	20.2500	49.8750	NA	23.93749	NA
##	2000-01-06	399.8750	20.6250	49.4375	NA	26.49997	NA
##	2000-01-07	407.0000	21.4375	50.8125	NA	27.24998	NA
##	2000-01-10	407.2500	22.0000	52.3750	NA	25.87499	NA
##		MAR.Close	MMC.Close	MLM.Close	MAS.Close	MA.Close	MAT.Close
##	2000-01-03	30.50005	94.5625	40.5000	25.1875	NA	13.0625
##	2000-01-04	30.31254	90.3125	39.9375	24.5625	NA	13.1875
##	2000-01-05	30.81255	87.0625	42.0000	23.4375	NA	12.7500
##	2000-01-06	31.25005	92.4375	45.1250	23.6875	NA	13.0625
##	2000-01-07	32.12505	95.3750	47.0000	24.5625	NA	12.6875
##	2000-01-10	33.81255	95.7500	46.3125	23.8750	NA	13.0000
##		MKC.Close	MCD.Close	MCK.Close	MJN.Close	MDT.Close	MRK.Close
##	2000-01-03	27.9375	39.6250	23.4375	NA	34.2500	67.6250
##	2000-01-04	28.3125	38.8125	21.9375	NA	34.5000	65.2500
##	2000-01-05	28.5625	39.4375	22.1875	NA	36.6250	67.8125
##	2000-01-06	28.1875	38.8750	23.7500	NA	38.0000	68.3750
##	2000-01-07	28.0625	39.8750	23.5000	NA	42.2500	74.9375
##	2000-01-10	26.8125	40.0625	24.0000	NA	41.9375	72.7500
##		MET.Close	MTD.Close	KORS.Close	MCHP.Close	MU.Close	MSFT.Close
##	2000-01-03	NA	35.375	NA	67.9375	75.9375	116.5625
##	2000-01-04	NA	34.625	NA	63.0625	73.0000	112.6250
##	2000-01-05	NA	33.875	NA	63.5625	72.7500	113.8125
##	2000-01-06	NA	34.625	NA	61.8750	74.0000	110.0000
##	2000-01-07	NA	35.625	NA	60.2500	70.5000	111.4375
##	2000-01-10	NA	37.250	NA	64.6250	74.3750	112.2500
##		MAA.Close	MHK.Close	TAP.Close	MDLZ.Close	MON.Close	MNST.Close
##	2000-01-03	22.5000	24.5625	50.6875	NA	NA	4.3125
##	2000-01-04	22.6250	24.0000	50.0625	NA	NA	4.1250
##	2000-01-05	22.3750	24.4375	52.4375	NA	NA	4.1250
##	2000-01-06	22.7500	24.3125	51.8125	NA	NA	4.2500
##	2000-01-07	22.9375	24.6250	52.9375	NA	NA	4.1562
##	2000-01-10	22.7500	24.8125	50.8750	NA	NA	4.1875
##		MCO.Close	MS.Close	MSI.Close	MUR.Close	MYL.Close	NDAQ.Close
##	2000-01-03	21.625	135.0000	149.0002	55.62499	24.375	NA
##	2000-01-04	21.000	125.0000	137.8752	56.43749	23.250	NA
##	2000-01-05	20.625	120.4375	134.2502	56.56251	23.625	NA
##	2000-01-06	20.625	122.7500	119.0002	57.00000	23.750	NA
##	2000-01-07	21.125	126.5625	128.8127	59.75002	25.000	NA
##	2000-01-10	21.125	130.6250	139.7502	58.75002	25.500	NA
##		NOV.Close	NAVI.Close	NTAP.Close	NFLX.Close	NWL.Close	NFX.Close
##	2000-01-03	14.62500	NA	85.0000	NA	27.7500	24.6250
##	2000-01-04	14.25001	NA	74.2500	NA	28.4375	25.5000
##	2000-01-05	14.50000	NA	78.3750	NA	28.0000	25.8125
##	2000-01-06	15.06250	NA	70.0625	NA	28.5625	26.3125
##	2000-01-07	16.12499	NA	85.0000	NA	29.5000	27.8750
##	2000-01-10	16.00001	NA	88.6250	NA	28.9375	27.5000
##		NEM.Close	NWSA.Close	NWS.Close	NEE.Close	NLSN.Close	NKE.Close

##	2000-01-03	24.0625	NA	NA	41.250	NA	48.1250
##	2000-01-04	22.2500	NA	NA	42.000	NA	45.5000
##	2000-01-05	22.5000	NA	NA	43.375	NA	48.1250
##	2000-01-06	22.2500	NA	NA	43.375	NA	47.8750
##	2000-01-07	21.4375	NA	NA	44.625	NA	47.8750
##	2000-01-10	21.3750	NA	NA	44.250	NA	48.6875
##		NI.Close	NBL.Close	JWN.Close	NSC.Close	NTRS.Close	NOC.Close
##	2000-01-03	17.6250	20.25000	25.7500	20.1250	50.46875	52.87491
##	2000-01-04	17.8125	19.56248	24.7500	20.2500	47.18750	53.56241
##	2000-01-05	18.5625	19.37500	24.3125	20.1250	48.25000	53.49991
##	2000-01-06	18.4375	20.50000	25.5000	21.3125	49.25000	52.49991
##	2000-01-07	18.3750	20.81248	25.5000	20.6875	49.87500	53.74991
##	2000-01-10	18.8125	20.12500	25.2500	21.3125	48.62500	53.12491
##		NRG.Close	NUE.Close	NVDA.Close	ORLY.Close	OXY.Close	OMC.Close
##	2000-01-03	NA	54.31248	46.8125	21.5000	20.8125	96.8750
##	2000-01-04	NA	53.75000	45.5625	19.9375	20.3750	93.6875
##	2000-01-05	NA	55.25000	44.0625	20.0625	20.5000	91.0000
##	2000-01-06	NA	55.75000	41.1875	18.9375	21.0625	91.5000
##	2000-01-07	NA	55.93752	41.8750	16.6250	21.6875	95.3750
##	2000-01-10	NA	53.93752	43.2500	16.8125	21.0000	99.6250
##		OKE.Close	ORCL.Close	PCAR.Close	PH.Close	PDCO.Close	PAYX.Close
##	2000-01-03	24.8125	118.1250	43.49999	48.81251	42.2500	40.00001
##	2000-01-04	24.5000	107.6875	41.49999	46.87500	40.1250	37.00001
##	2000-01-05	24.7500	102.0000	43.18748	46.87500	44.7500	39.18750
##	2000-01-06	24.7500	96.0000	42.62499	47.74999	44.6250	40.62499
##	2000-01-07	25.6875	103.3750	44.24999	52.12500	45.2500	41.43750
##	2000-01-10	25.6250	115.7500	46.06252	51.49999	45.7187	42.12499
##		PYPL.Close	PNR.Close	PBCT.Close	PEP.Close	PKI.Close	PRGO.Close
##	2000-01-03	NA	36.1875	20.87500	36.8750	41.4375	8.12500
##	2000-01-04	NA	35.6250	20.81249	35.9375	39.5000	8.06250
##	2000-01-05	NA	36.1875	20.93751	35.0625	39.0625	8.06250
##	2000-01-06	NA	36.0000	20.74998	36.6250	39.5625	8.12500
##	2000-01-07	NA	37.4375	20.62500	37.6250	40.0625	8.34375
##	2000-01-10	NA	36.3750	20.24998	36.8750	41.6875	8.50000
##		PFE.Close	PCG.Close	PM.Close	PSX.Close	PNW.Close	PXD.Close
##	2000-01-03	31.8750	19.8125	NA	NA	29.7500	8.4375
##	2000-01-04	30.6875	20.6875	NA	NA	30.1250	8.5625
##	2000-01-05	31.1875	22.0625	NA	NA	30.9375	8.3125
##	2000-01-06	32.3125	22.2500	NA	NA	31.1250	8.5000
##	2000-01-07	34.5000	22.2500	NA	NA	32.0000	8.7500
##	2000-01-10	34.4375	21.8125	NA	NA	31.5625	8.5000
##		PNC.Close	RL.Close	PPG.Close	PPL.Close	PX.Close	PCLN.Close
##	2000-01-03	42.1875	17.4375	60.0000	22.1875	49.8125	51.25010
##	2000-01-04	40.8750	16.7500	57.9375	22.7500	48.9375	54.00011
##	2000-01-05	41.0625	17.0625	60.1250	23.2500	49.8125	59.93762
##	2000-01-06	43.0000	17.0625	63.0000	22.9375	53.5000	57.50012
##	2000-01-07	43.0625	17.5000	64.1250	23.3750	53.5625	57.25011
##	2000-01-10	41.5625	18.2500	62.1250	23.1250	53.6250	54.25011
##		PFGB.Close	PG.Close	PGR.Close	PLD.Close	PRU.Close	PEG.Close
##	2000-01-03	NA	107.1875	70.6875	19.8125	NA	34.0625
##	2000-01-04	NA	105.1250	68.1250	19.5000	NA	34.3125
##	2000-01-05	NA	103.1250	69.7500	19.2500	NA	35.1875
##	2000-01-06	NA	107.8750	69.5000	19.6250	NA	35.3125
##	2000-01-07	NA	116.5000	70.6875	20.0000	NA	35.0625

##	2000-01-10	NA	115.9375	69.3125	20.1250	NA	35.0000
##		PSA.Close	PHM.Close	PVH.Close	QRVO.Close	QCOM.Close	PWR.Close
##	2000-01-03	22.7500	21.12500	7.8125	NA	179.3125	28.18751
##	2000-01-04	22.7500	20.12500	7.5000	NA	162.0625	28.12500
##	2000-01-05	22.9375	19.75000	7.3750	NA	156.4375	28.56251
##	2000-01-06	23.8125	19.62500	7.5625	NA	140.0625	28.00001
##	2000-01-07	24.1250	19.93752	7.3750	NA	150.0000	27.87499
##	2000-01-10	24.6250	19.56248	7.0625	NA	159.3750	28.06249
##		DGX.Close	RRC.Close	RTN.Close	O.Close	RHT.Close	REG.Close
##	2000-01-03	30.00000	2.812500	26.1250	20.750	231.50	19.9375
##	2000-01-04	29.93752	2.749995	25.9375	20.500	215.00	20.0000
##	2000-01-05	29.68752	2.687505	26.2500	20.375	256.00	19.8750
##	2000-01-06	29.81248	2.749995	26.3750	20.625	228.25	20.0000
##	2000-01-07	31.00000	2.749995	27.9375	21.000	264.50	20.6875
##	2000-01-10	31.56248	2.687505	27.6250	21.375	141.25	20.7500
##		REGN.Close	RF.Close	RSG.Close	RAI.Close	RHI.Close	ROK.Close
##	2000-01-03	12.3125	23.50001	14.1250	17.8125	27.9375	49.3750
##	2000-01-04	12.0000	22.81249	13.2500	18.0000	26.4375	47.5625
##	2000-01-05	11.5000	22.68750	13.0000	18.4375	25.9375	47.8125
##	2000-01-06	11.6250	22.75000	12.9375	18.7500	25.9375	46.8750
##	2000-01-07	13.0000	23.00001	13.6250	19.4375	26.4375	48.3125
##	2000-01-10	14.5000	22.00000	13.6875	19.8125	26.6250	48.3125
##		COL.Close	ROP.Close	ROST.Close	RCL.Close	R.Close	SPGI.Close
##	2000-01-03	NA	35.5625	17.3750	46.3750	23.6250	58.4375
##	2000-01-04	NA	33.9375	16.6250	44.8125	22.3125	55.7500
##	2000-01-05	NA	33.5000	17.0000	47.5625	22.7500	55.0000
##	2000-01-06	NA	33.5000	15.1875	48.5000	24.6250	53.5000
##	2000-01-07	NA	34.0000	15.0000	49.2500	25.1250	54.0000
##	2000-01-10	NA	34.3125	15.2500	51.9375	24.0000	57.7500
##		CRM.Close	SCG.Close	SLB.Close	SNI.Close	STX.Close	SEE.Close
##	2000-01-03	NA	26.6875	54.9375	NA	NA	52.1875
##	2000-01-04	NA	26.1875	54.1875	NA	NA	54.1875
##	2000-01-05	NA	26.4375	54.0625	NA	NA	54.1875
##	2000-01-06	NA	26.1250	57.7500	NA	NA	55.6250
##	2000-01-07	NA	26.3125	58.8125	NA	NA	57.6250
##	2000-01-10	NA	26.2500	59.3750	NA	NA	59.3125
##		SRE.Close	SHW.Close	SIG.Close	SPG.Close	SWKS.Close	SLG.Close
##	2000-01-03	17.3125	20.1250	32.500	22.6250	62.8125	21.5625
##	2000-01-04	17.5000	19.3750	32.625	22.3750	59.1250	21.2500
##	2000-01-05	17.8750	19.4375	32.625	22.5625	60.6562	21.0625
##	2000-01-06	18.3750	19.7500	34.125	23.1250	54.7500	21.4375
##	2000-01-07	18.0000	19.5000	33.500	24.1250	60.3750	22.1875
##	2000-01-10	17.8125	19.0625	33.500	24.3750	57.0937	22.5625
##		SNA.Close	SO.Close	LUV.Close	SWN.Close	SWK.Close	SPLS.Close
##	2000-01-03	26.8750	22.75001	15.8750	6.62496	28.750	20.6250
##	2000-01-04	26.5625	23.00001	15.4375	6.68752	28.125	20.7500
##	2000-01-05	25.5625	24.18751	15.3750	6.43752	27.750	22.5000
##	2000-01-06	25.6250	24.25001	15.3125	6.43752	27.625	23.9375
##	2000-01-07	26.2500	24.68751	15.8750	6.37504	28.125	25.3125
##	2000-01-10	25.7500	24.50001	16.0625	6.37504	27.875	27.3125
##		SBUX.Close	STT.Close	SRCL.Close	SYK.Close	STI.Close	SYMC.Close
##	2000-01-03	24.6562	69.7500	17.87500	68.3750	64.6875	56.8750
##	2000-01-04	23.8750	65.8750	17.12500	67.6250	62.3125	54.2500
##	2000-01-05	24.1875	67.0625	17.00000	69.6875	61.6250	51.0000

##	2000-01-06	25.0625	69.8750	16.93752	71.1875	62.4375	48.0625
##	2000-01-07	24.9375	72.3750	16.93752	77.7500	62.3125	51.8750
##	2000-01-10	26.0000	71.9375	16.75000	76.8750	59.5000	56.7500
##		SYF.Close	SYY.Close	TROW.Close	TGT.Close	TEL.Close	TGNA.Close
##	2000-01-03	NA	38.1250	35.1250	72.0625	NA	78.6875
##	2000-01-04	NA	36.9375	34.0625	68.9375	NA	77.2500
##	2000-01-05	NA	37.2500	34.0000	67.3750	NA	75.8750
##	2000-01-06	NA	38.8125	35.0000	64.1875	NA	75.1250
##	2000-01-07	NA	38.8750	34.7500	67.5000	NA	75.0625
##	2000-01-10	NA	39.0000	35.1250	66.1875	NA	78.3125
##		TDC.Close	TSO.Close	TXN.Close	TXT.Close	BK.Close	CLX.Close
##	2000-01-03	NA	10.7500	102.8750	74.9375	37.0000	49.1875
##	2000-01-04	NA	10.4375	98.5000	73.6875	35.9375	47.8750
##	2000-01-05	NA	10.3125	96.1250	71.9375	35.1250	49.1250
##	2000-01-06	NA	10.1250	93.5000	71.0000	36.0000	49.5625
##	2000-01-07	NA	10.0000	94.0000	72.7500	37.8750	52.3125
##	2000-01-10	NA	9.8750	100.4375	73.6250	36.1875	51.7500
##		COO.Close	HSY.Close	MOS.Close	TRV.Close	DIS.Close	TMO.Close
##	2000-01-03	29.5000	46.3750	16.750	33.0000	29.8750	15.0000
##	2000-01-04	29.7500	44.6250	16.375	32.5625	31.6250	14.4375
##	2000-01-05	29.9375	44.8125	17.000	32.3125	32.9375	14.5625
##	2000-01-06	29.9375	46.0000	17.250	32.9375	31.6250	14.5625
##	2000-01-07	30.1875	46.1250	17.500	34.2500	31.1250	14.7500
##	2000-01-10	30.2500	46.2500	18.625	33.6250	35.8750	14.6250
##		TIF.Close	TWX.Close	TJX.Close	TMK.Close	TSS.Close	TSC0.Close
##	2000-01-03	84.9375	82.99841	20.3125	28.31249	16.1250	15.8750
##	2000-01-04	82.2500	76.99853	19.2500	27.74999	16.0625	15.5312
##	2000-01-05	80.2500	74.06108	18.6875	27.74999	16.2500	15.6250
##	2000-01-06	77.0000	68.74868	19.8125	27.68749	16.0000	15.3750
##	2000-01-07	82.4375	73.74859	20.3125	28.24999	16.1250	15.7500
##	2000-01-10	88.0000	72.62361	20.0000	27.87500	16.3750	15.0000
##		TDG.Close	RIG.Close	TRIP.Close	FOXA.Close	FOX.Close	TSN.Close
##	2000-01-03	NA	32.8125	NA	33.37500	37.81249	16.0625
##	2000-01-04	NA	30.9375	NA	32.25000	36.87499	16.0000
##	2000-01-05	NA	29.8750	NA	32.75001	37.87500	16.0625
##	2000-01-06	NA	32.1250	NA	33.06251	37.43750	16.1875
##	2000-01-07	NA	34.0000	NA	32.87500	37.75000	16.9375
##	2000-01-10	NA	34.0625	NA	38.87501	45.06250	16.7500
##		USB.Close	UDR.Close	ULTA.Close	UA.Close	UAA.Close	UNP.Close
##	2000-01-03	20.5625	9.9375	NA	NA	NA	43.06248
##	2000-01-04	19.8125	9.5000	NA	NA	NA	43.00000
##	2000-01-05	19.3750	9.6875	NA	NA	NA	43.00000
##	2000-01-06	20.8750	10.3750	NA	NA	NA	45.62500
##	2000-01-07	21.6875	10.1875	NA	NA	NA	45.31248
##	2000-01-10	21.5625	10.1875	NA	NA	NA	46.37500
##		UAL.Close	UNH.Close	UPS.Close	URI.Close	UTX.Close	UHS.Close
##	2000-01-03	NA	53.7500	67.0625	16.6875	62.5000	37.25000
##	2000-01-04	NA	53.0625	64.9375	16.5000	59.9375	36.50000
##	2000-01-05	NA	52.9375	68.0000	16.4375	58.7500	38.00000
##	2000-01-06	NA	54.8750	68.0000	17.3750	61.5625	40.81248
##	2000-01-07	NA	61.3125	66.3750	17.9375	64.0000	44.18752
##	2000-01-10	NA	60.2500	67.0625	17.8125	64.6250	46.31248
##		UNM.Close	URBN.Close	VFC.Close	VLO.Close	VAR.Close	VTR.Close
##	2000-01-03	30.5000	27.50000	29.62500	19.12500	28.75000	4.0000

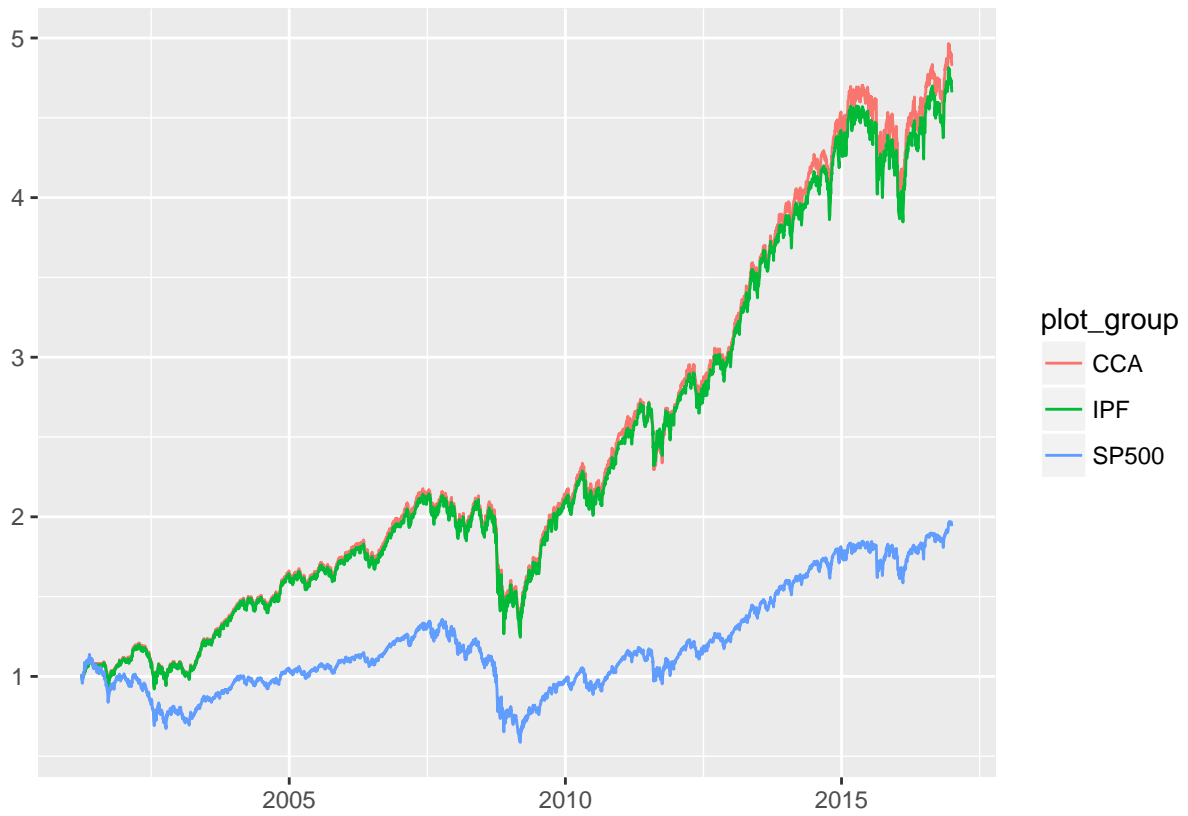
##	2000-01-04	29.9375	26.00000	29.31248	18.93749	28.56248	4.0000
##	2000-01-05	28.9375	23.37504	29.00000	19.62500	29.54688	3.9375
##	2000-01-06	29.5625	14.37504	28.56248	20.24998	29.62500	4.0000
##	2000-01-07	30.0000	13.12496	29.18752	19.99998	29.81248	3.9375
##	2000-01-10	29.8750	13.43752	29.56248	19.93749	30.12500	4.0000
##		VRSN.Close	VRSK.Close	VZ.Close	VRTX.Close	VIAB.Close	V.Close
##	2000-01-03	190.1250	NA	59.93762	37.5625	NA	NA
##	2000-01-04	188.3750	NA	58.00012	34.5625	NA	NA
##	2000-01-05	178.0000	NA	59.93762	34.0000	NA	NA
##	2000-01-06	155.1250	NA	59.25012	33.5000	NA	NA
##	2000-01-07	169.8281	NA	58.81262	36.4375	NA	NA
##	2000-01-10	181.7500	NA	58.50012	37.5625	NA	NA
##		VNO.Close	VMC.Close	WMT.Close	WBA.Close	WM.Close	WAT.Close
##	2000-01-03	33.3750	39.3750	66.8125	28.5625	17.3750	51.5000
##	2000-01-04	33.3750	39.2500	64.3125	27.5000	17.3125	49.0000
##	2000-01-05	34.2500	41.8750	63.0000	27.8125	17.3750	52.0625
##	2000-01-06	34.6875	41.9375	63.6875	27.0000	17.2500	50.5000
##	2000-01-07	34.9375	42.0625	68.5000	27.6875	16.5625	52.0625
##	2000-01-10	35.2500	43.7500	67.2500	28.5000	16.6250	50.3125
##		WEC.Close	WFC.Close	HCN.Close	WDC.Close	WU.Close	WRK.Close
##	2000-01-03	19.0625	39.1250	15.3750	3.9375	NA	NA
##	2000-01-04	19.1875	37.1875	15.3125	4.6875	NA	NA
##	2000-01-05	20.0625	36.8125	15.7500	4.3750	NA	NA
##	2000-01-06	20.0000	38.4375	16.5625	4.5625	NA	NA
##	2000-01-07	20.2500	39.1250	16.8125	5.6250	NA	NA
##	2000-01-10	20.2500	37.8750	17.1250	5.0000	NA	NA
##		WY.Close	WHR.Close	WFM.Close	WMB.Close	WLTW.Close	WYN.Close
##	2000-01-03	69.8750	61.8125	44.4375	31.00007	NA	NA
##	2000-01-04	67.2500	59.4375	43.4687	30.31257	NA	NA
##	2000-01-05	70.8125	60.3125	42.3125	32.18758	NA	NA
##	2000-01-06	74.1250	60.8125	43.7500	32.87507	NA	NA
##	2000-01-07	71.6875	61.0000	43.4375	33.75008	NA	NA
##	2000-01-10	71.3750	61.7500	43.6562	33.12508	NA	NA
##		WYNN.Close	XEL.Close	XRX.Close	XLNX.Close	XL.Close	XYL.Close
##	2000-01-03	NA	19.0000	24.1875	46.7500	51.3750	NA
##	2000-01-04	NA	19.4375	23.0625	45.6875	49.0625	NA
##	2000-01-05	NA	20.1875	24.2500	44.6875	49.5000	NA
##	2000-01-06	NA	20.0000	23.7500	40.8125	49.8750	NA
##	2000-01-07	NA	20.0000	24.3125	45.4375	53.1875	NA
##	2000-01-10	NA	20.0000	23.7500	47.7500	54.0000	NA
##		YH00.Close	YUM.Close	ZBH.Close	ZION.Close	ZTS.Close	GSPC.Close
##	2000-01-03	475.0000	37.3125	NA	55.50000	NA	1455.22
##	2000-01-04	443.0000	36.5625	NA	52.81250	NA	1399.42
##	2000-01-05	410.5000	36.7500	NA	52.75000	NA	1402.11
##	2000-01-06	368.1875	36.4375	NA	53.50000	NA	1403.45
##	2000-01-07	407.2500	35.6250	NA	53.62500	NA	1441.47
##	2000-01-10	436.0625	37.0625	NA	52.65625	NA	1457.60
##	nwks: 375						
##	CCA 0.01722515						
##	...Algorithm 10.009159606						
##	...Algorithm 10.01746686						
##	...Algorithm 10.01340865						
##	...Algorithm 10.01564766						

```

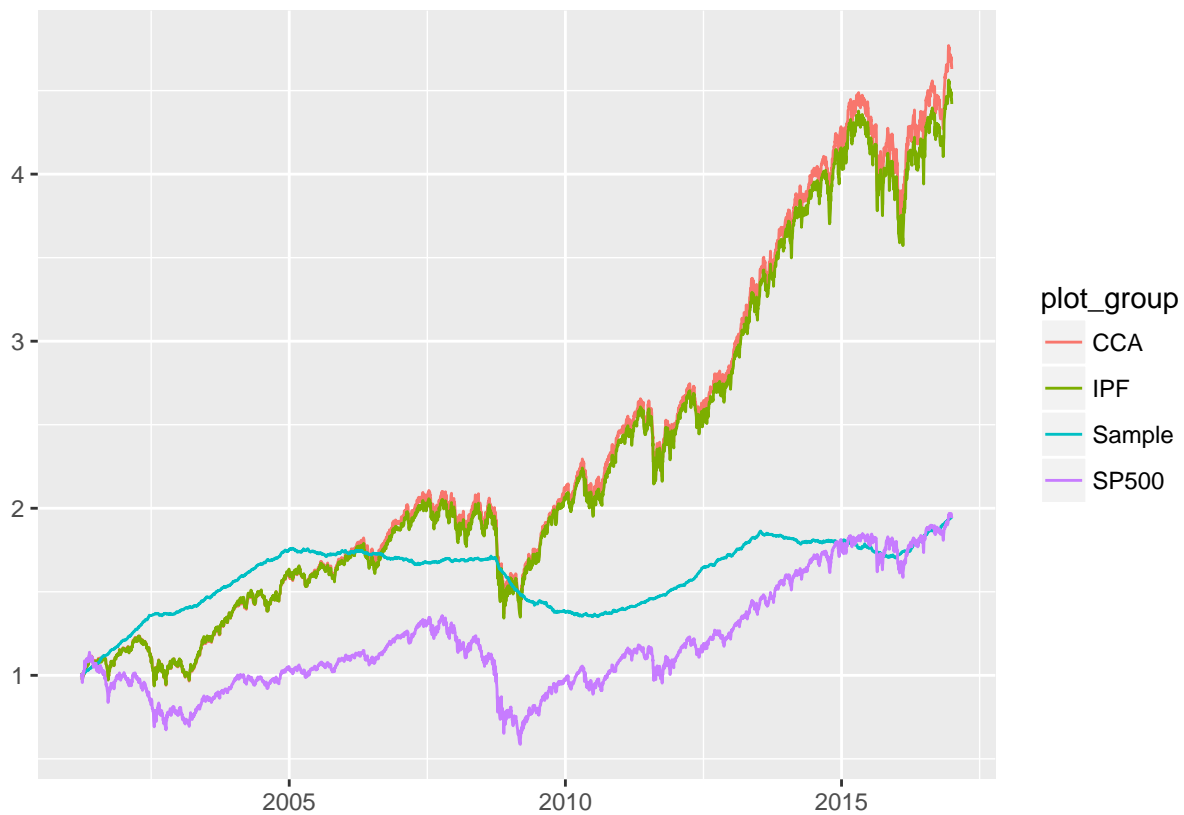
## ...Algorithm 10.01152584
## ...Algorithm 10.02655014
## ...Algorithm 10.008650739
## ...Algorithm 10.01409562
## ...Algorithm 10.02945068
## ...Algorithm 10.02901814
## ...Algorithm 10.05378724
## ...Algorithm 10.02693179
## ...Algorithm 10.03745261
## ...Algorithm 1IPF 0.01722515
## ...IPF0.009159606
## ...IPF0.01746686
## ...IPF0.01340865
## ...IPF0.01564766
## ...IPF0.01152584
## ...IPF0.02655014
## ...IPF0.008650739
## ...IPF0.01409562
## ...IPF0.02945068
## ...IPF0.02901814
## ...IPF0.05378724
## ...IPF0.02693179
## ...IPF0.03745261
## ...IPFnwks: 450
## Sample CCA 0.01722515
## ...Algorithm 10.02275908
## ...Algorithm 10.009617586
## ...Algorithm 10.02551968
## ...Algorithm 10.03953897
## ...Algorithm 10.04310104
## ...Algorithm 10.02044373
## ...Algorithm 10.02633387
## ...Algorithm 10.03553164
## ...Algorithm 10.008065542
## ...Algorithm 10.01563494
## ...Algorithm 10.0223647
## ...Algorithm 10.03438669
## ...Algorithm 10.02347149
## ...Algorithm 1IPF 0.01722515
## ...IPF0.02275908
## ...IPF0.009617586
## ...IPF0.02551968
## ...IPF0.03953897
## ...IPF0.04310104
## ...IPF0.02044373
## ...IPF0.02633387
## ...IPF0.03553164
## ...IPF0.008065542
## ...IPF0.01563494
## ...IPF0.0223647
## ...IPF0.03438669
## ...IPF0.02347149
## ...IPFnwks: 525
## Sample CCA 0.01722515

```

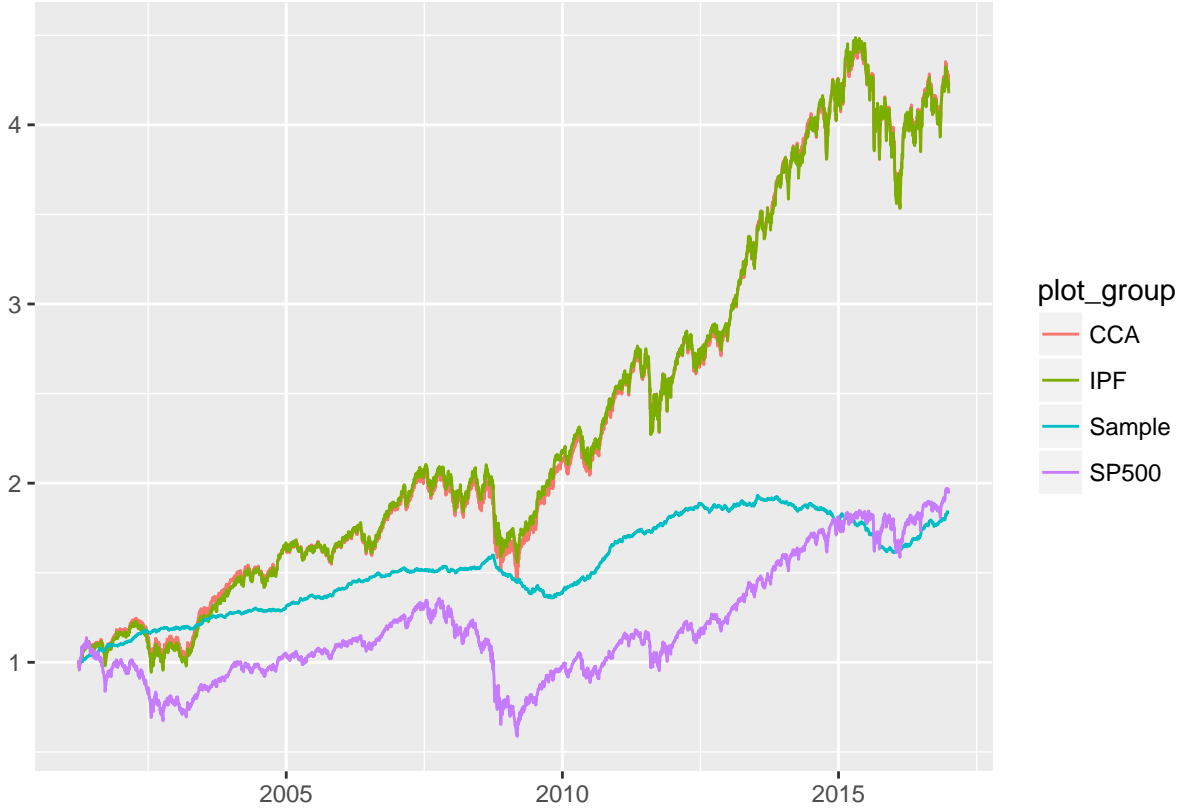
```
## ...Algorithm 10.03152431
## ...Algorithm 10.01312877
## ...Algorithm 10.03139709
## ...Algorithm 10.04876218
## ...Algorithm 10.008281811
## ...Algorithm 10.03408137
## ...Algorithm 10.04944915
## ...Algorithm 10.04176526
## ...Algorithm 10.01134773
## ...Algorithm 10.02508714
## ...Algorithm 10.03682925
## ...Algorithm 10.04091291
## ...Algorithm 10.04042948
## ...Algorithm 1IPF 0.01722515
## ...IPF0.03152431
## ...IPF0.01312877
## ...IPF0.03139709
## ...IPF0.04876218
## ...IPF0.008281811
## ...IPF0.03408137
## ...IPF0.04944915
## ...IPF0.04176526
## ...IPF0.01134773
## ...IPF0.02508714
## ...IPF0.03682925
## ...IPF0.04091291
## ...IPF0.04042948
## ...IPF
```



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Saving 6.5 x 4.5 in image



```
## Saving 6.5 x 4.5 in image
```

```
xtable(as.data.frame(rbind(timeCCA, timeIPF)))
```

```
% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:50 2017
```

	V1	V2	V3	375	450	525
timeCCA	1.97	1.86	1.87	1.97	1.86	1.87
timeIPF	0.00	0.00	0.00	4.48	4.55	5.92

Realized Risk and Realized Return

Mean and SD of Short side

Define the investment periods $k = 1, \dots, K$. The total number of days in the investment period is

$$T = \sum_{k=1}^K L_k$$

where L_k is the number of days in k -th investment period. When the investment periods are selected by calendar periods (months, weeks, fiscal quarters, etc), the number of trading days vary.

For notational simplicity, define cumulative number of trading days before the first day of the j -th period ($j = 1, \dots, K$) as

$$T_j = \sum_{k=1}^j L_k$$

Portfolio weights for the k -th investment period is

$$w_k = (w_{1k}, w_{2k}, \dots, w_{pk})'$$

with $\sum_{i=1}^p w_{ik} = 1$ for all $k = 1, \dots, K$.

Short side

The short side of portfolio weights w_k for the k -th investment period is

$$SS(k) = \frac{\sum_{i=1}^p |\min(w_{ik}, 0)|}{\sum_{i=1}^p |w_{ik}|}$$

Mean and SD of the short side over the all investment periods is

$$\bar{SS} = \frac{1}{K} \sum_{k=1}^K SS(k), \quad \hat{\sigma}_{SS} = \left(\frac{1}{K} \sum_{k=1}^K (SS(k) - \bar{SS})^2 \right)^{1/2}$$

```
xtable(ss * 100)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:52 2017

	Sample	CCA	IPF
375	0.00	35.13	30.33
450	805.28	47.66	42.53
525	555.83	66.65	58.21

```
xtable(sdss * 100)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:52 2017

	Sample	CCA	IPF
375	0.00	21.11	15.37
450	229.14	18.93	15.62
525	168.27	30.71	26.23

Turnover, Average TO, SD TO

Turnover for k -th investment period given portfolio weights w_k held constant is

$$TO(k) = \sum_{i=1}^p \left| w_i^k - \prod_{d=T_{k-1}+1}^{T_{k-1}+L_k} (1 + r_{id}) w_i^{(k-1)} \right|$$

with $w_i^{(0)} = 0$ for all $i = 1, \dots, p$.

```
xtable(avgT0)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:53 2017

	Sample	CCA	IPF
375		1.83	1.63
450	23.17	2.11	1.84
525	15.46	2.70	2.23

```
xtable(sdT0)
```

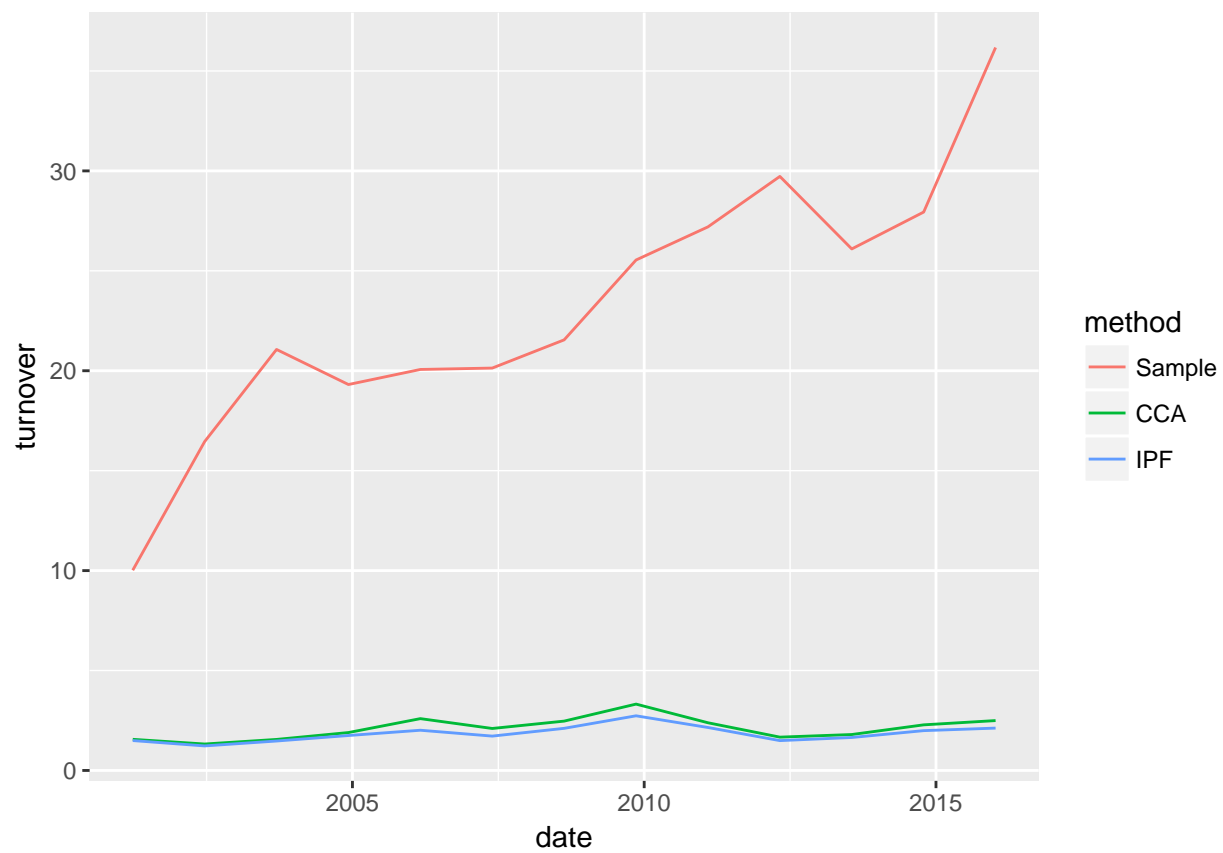
% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:53 2017

	Sample	CCA	IPF
1			
2			
3			
375		0.52	0.34
450	6.61	0.55	0.40
525	4.59	0.84	0.65

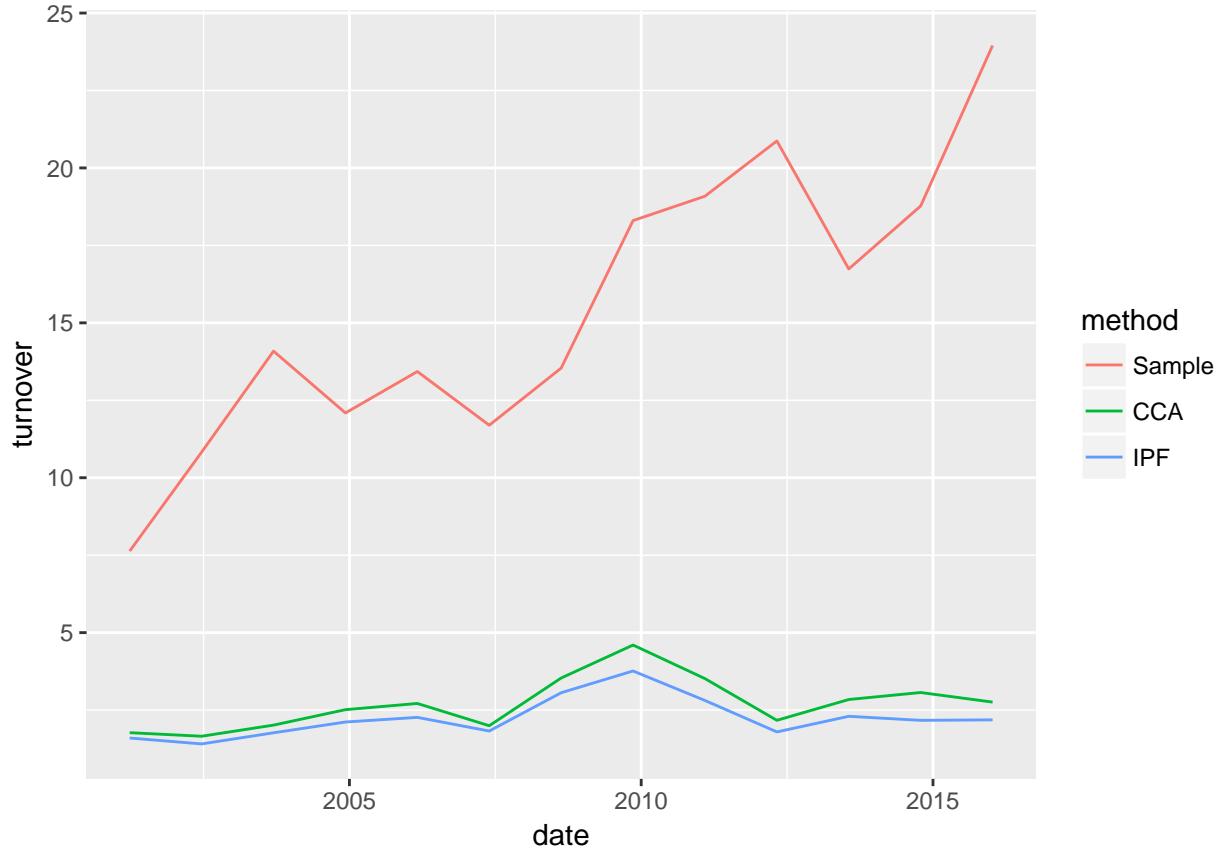
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Realized Return

Realized return is

$$r_p = \frac{1}{p} \sum_{i=1}^p \left(\frac{1}{T} \sum_{d=1}^T r_{id} w_i^{(k_d)} \right)$$

where k_d denotes the investment period the d -th day falls in.

$$k_d = \{k : d \in [T_{k-1}, T_k]\}$$

annualized for 250 working days

```
rret <- rpmine * 250 * 100
xtable(rret)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:54 2017

	Sample	CCA	IPF	SP500
375	0.00	11.30	11.06	6.07
450	4.22	10.92	10.61	6.07
525	3.88	10.12	10.03	6.07

Realized risk

Realized risk is

$$\sigma_p = \left(\frac{1}{p} \sum_{i=1}^p \left(\frac{1}{T} \sum_{d=1}^T (r_{id} w_i^{(k_d)})^2 \right) - r_p^2 \right)^{1/2}$$

annualized for 250 working days

```
rrisk <- spmine * 250 * 100/sqrt(250)
xtable(rrisk)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:54 2017

	Sample	CCA	IPF	SP500
375	0.00	16.19	16.05	19.42
450	2.19	15.51	15.36	19.42
525	3.25	14.00	13.73	19.42

Sharpe ratio

Sharpe ratio (SR) is

$$SR = \frac{r_p - r_f}{\sigma_p}$$

where annual percentage rate (APR) of 3% is used. Conversion to daily rate r_f is computed as

$$r_f = \frac{0.035}{250} =$$

for 250 trading days per year.

Annualized Shape ratio is

```
xtable(sr * sqrt(250), digits = 3)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:43:54 2017

	Sample	CCA	IPF	SP500
375	0.000	0.482	0.471	0.132
450	0.329	0.479	0.463	0.132
525	0.118	0.473	0.475	0.132

Effect of transaction and borrowing costs

The borrowing cost rate payable at the beginning of k -th period depends on the short side of portfolio weights during the $(k - 1)$ -th period. Denote the borrowing rate (daily APR) by r_b , then the borrowing cost rate is given by

$$BC(k) = ((1 + r_b)^{L_{k-1}} - 1) \cdot SS(k)$$

The transaction cost incurred is a function of turnover to k -th period from the previous. Denote the transaction cost rate by r_c , then the transaction cost incurred is given by

$$TC(k) = r_c \cdot TO(k)$$

Let $W(d)$ denote the wealth of the portfolio after the d -th trading day. On the first day of each trading period, we adjust the return for these costs.

$$W(d) = \begin{cases} W(d-1) \left(1 + \sum_{i=1}^p r_{id} w_i^{(k_d)} - TC(k_d) - BC(k_d) \right), & d = T_{k_d-1} + 1 \\ W(d-1) \left(1 + \sum_{i=1}^p r_{id} w_i^{(k_d)} \right), & d \neq \{T_{k_d-1} + 1 | k_d = 1, \dots, K\} \end{cases}$$

```
## 1_1_0.07_0.005
## 0_1_0.07_0.005
## 1_0_0.07_0.005
## 0_0_0.07_0.005
## 1_1_0.08_0.005
## 0_1_0.08_0.005
## 1_0_0.08_0.005
## 0_0_0.08_0.005
## 1_1_0.07_0.03
## 0_1_0.07_0.03
## 1_0_0.07_0.03
## 0_0_0.07_0.03
## 1_1_0.08_0.03
## 0_1_0.08_0.03
## 1_0_0.08_0.03
## 0_0_0.08_0.03
## 1_1_0.07_0.005
## 0_1_0.07_0.005
## 1_0_0.07_0.005
## 0_0_0.07_0.005
## 1_1_0.08_0.005
## 0_1_0.08_0.005
## 1_0_0.08_0.005
## 0_0_0.08_0.005
## 1_1_0.07_0.03
## 0_1_0.07_0.03
## 1_0_0.07_0.03
## 0_0_0.07_0.03
## 1_1_0.08_0.03
## 0_1_0.08_0.03
## 1_0_0.08_0.03
## 0_0_0.08_0.03
## 1_1_0.07_0.005
## 0_1_0.07_0.005
## 1_0_0.07_0.005
## 0_0_0.07_0.005
```

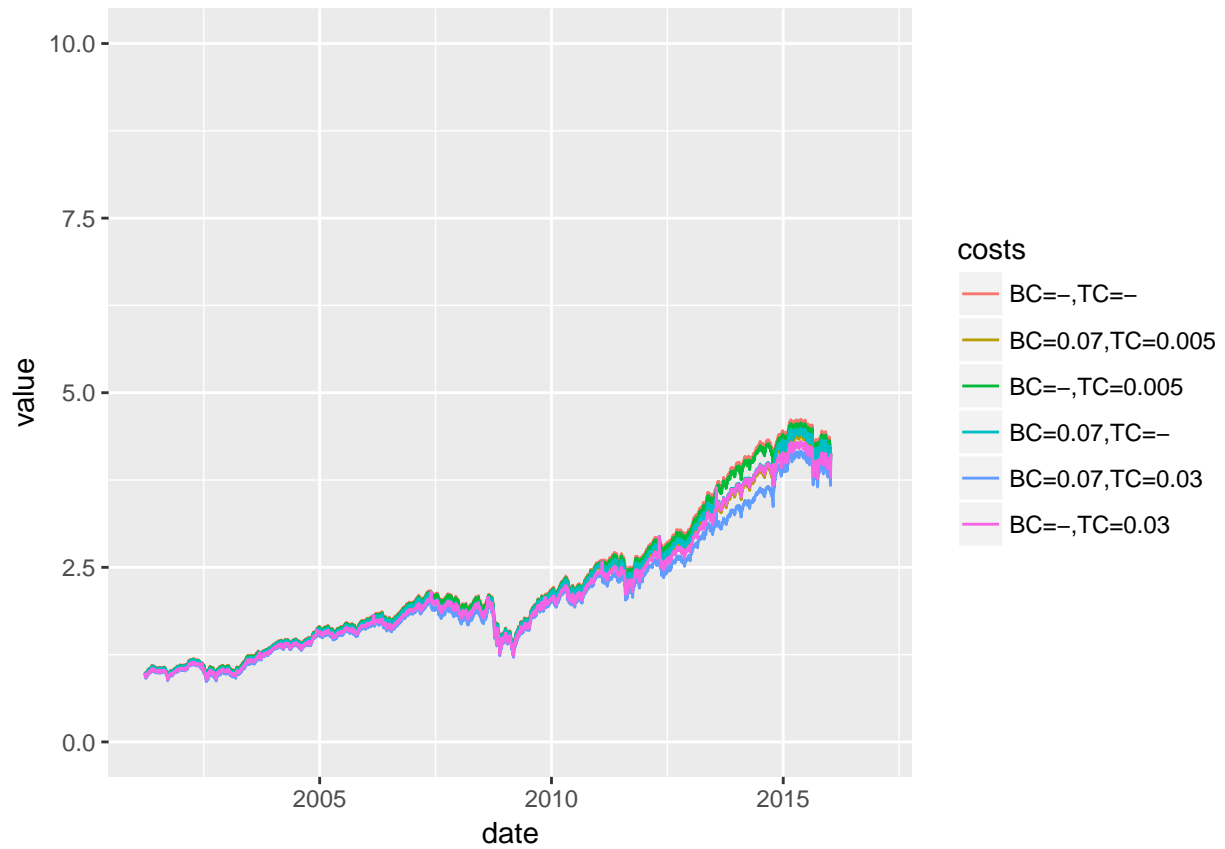

1_1_0.08_0.005
0_1_0.08_0.005
1_0_0.08_0.005
0_0_0.08_0.005
1_1_0.07_0.03
0_1_0.07_0.03
1_0_0.07_0.03
0_0_0.07_0.03
1_1_0.08_0.03
0_1_0.08_0.03
1_0_0.08_0.03
0_0_0.08_0.03
1_1_0.07_0.005
0_1_0.07_0.005
1_0_0.07_0.005
0_0_0.07_0.005
1_1_0.08_0.005
0_1_0.08_0.005
1_0_0.08_0.005
0_0_0.08_0.005
1_1_0.07_0.03
0_1_0.07_0.03
1_0_0.07_0.03
0_0_0.07_0.03
1_1_0.08_0.03
0_1_0.08_0.03
1_0_0.08_0.03
0_0_0.08_0.03
1_1_0.07_0.005
0_1_0.07_0.005
1_0_0.07_0.005
0_0_0.07_0.005
1_1_0.08_0.005
0_1_0.08_0.005
1_0_0.08_0.005
0_0_0.08_0.005
1_1_0.07_0.03
0_1_0.07_0.03
1_0_0.07_0.03
0_0_0.07_0.03
1_1_0.08_0.03
0_1_0.08_0.03
1_0_0.08_0.03
0_0_0.08_0.03
1_1_0.07_0.005
0_1_0.07_0.005
1_0_0.07_0.005
0_0_0.07_0.005
1_1_0.08_0.005
0_1_0.08_0.005
1_0_0.08_0.005
0_0_0.08_0.005
1_1_0.07_0.03
0_1_0.07_0.03

```

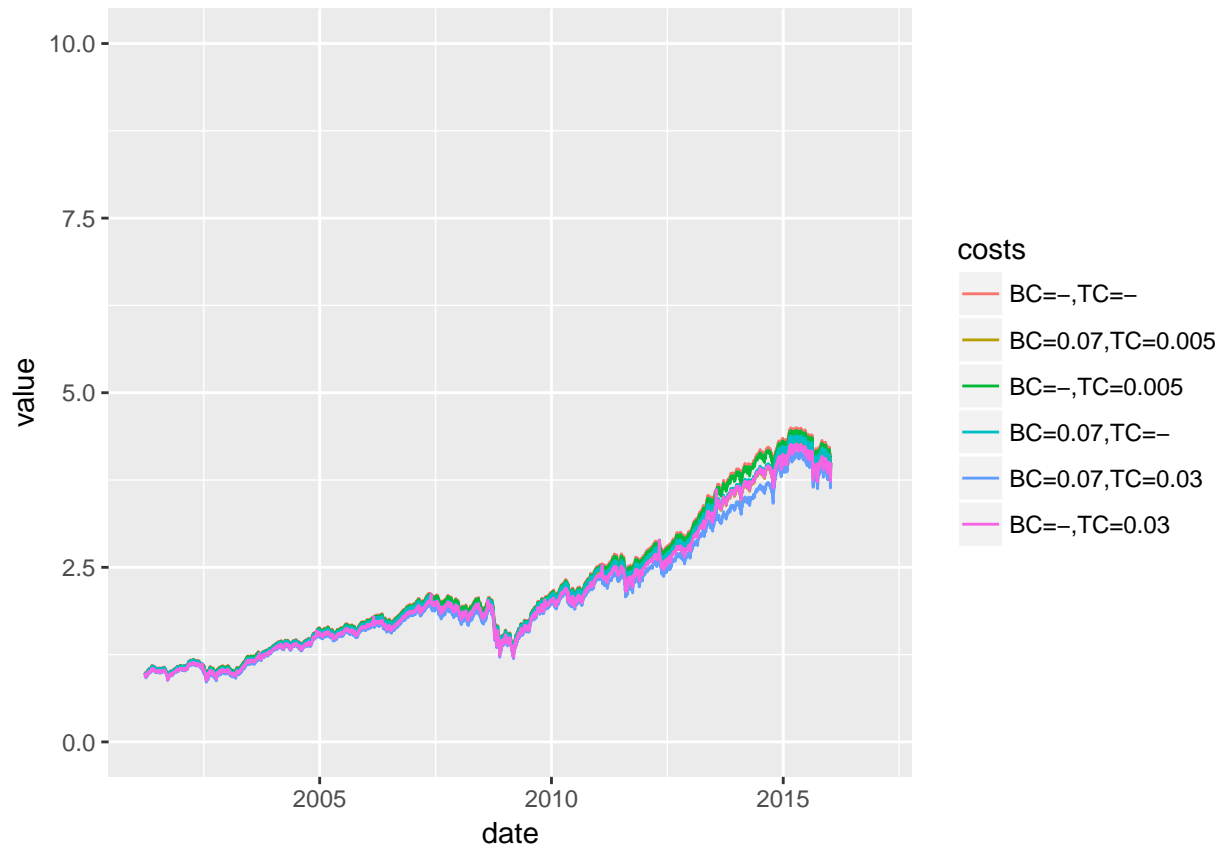
## 1_0_0.07_0.03
## 0_0_0.07_0.03
## 1_1_0.08_0.03
## 0_1_0.08_0.03
## 1_0_0.08_0.03
## 0_0_0.08_0.03
## 1_1_0.07_0.005
## 0_1_0.07_0.005
## 1_0_0.07_0.005
## 0_0_0.07_0.005
## 1_1_0.08_0.005
## 0_1_0.08_0.005
## 1_0_0.08_0.005
## 0_0_0.08_0.005
## 1_1_0.07_0.03
## 0_1_0.07_0.03
## 1_0_0.07_0.03
## 0_0_0.07_0.03
## 1_1_0.08_0.03
## 0_1_0.08_0.03
## 1_0_0.08_0.03
## 0_0_0.08_0.03
## 1_1_0.07_0.005
## 0_1_0.07_0.005
## 1_0_0.07_0.005
## 0_0_0.07_0.005
## 1_1_0.08_0.005
## 0_1_0.08_0.005
## 1_0_0.08_0.005
## 0_0_0.08_0.005
## 1_1_0.07_0.03
## 0_1_0.07_0.03
## 1_0_0.07_0.03
## 0_0_0.07_0.03
## 1_1_0.08_0.03
## 0_1_0.08_0.03
## 1_0_0.08_0.03
## 0_0_0.08_0.03

## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).

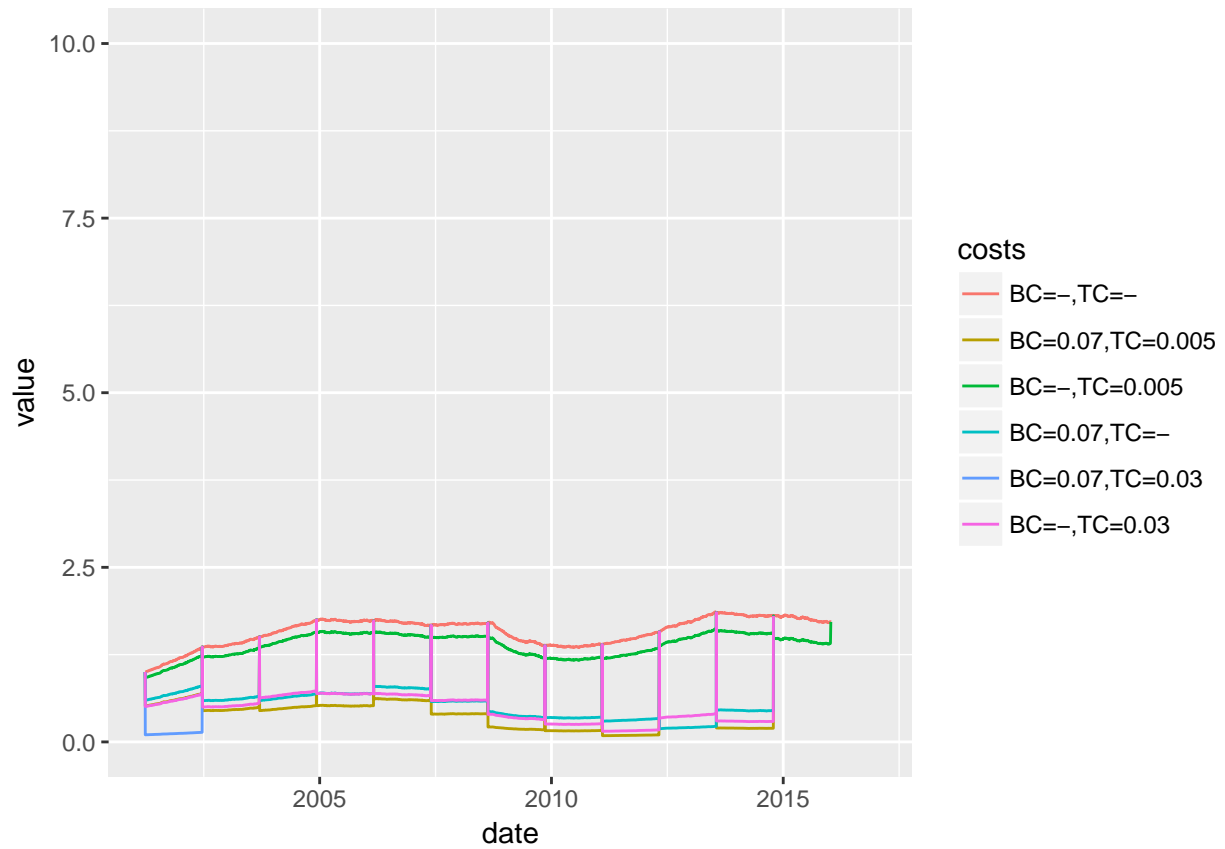
```



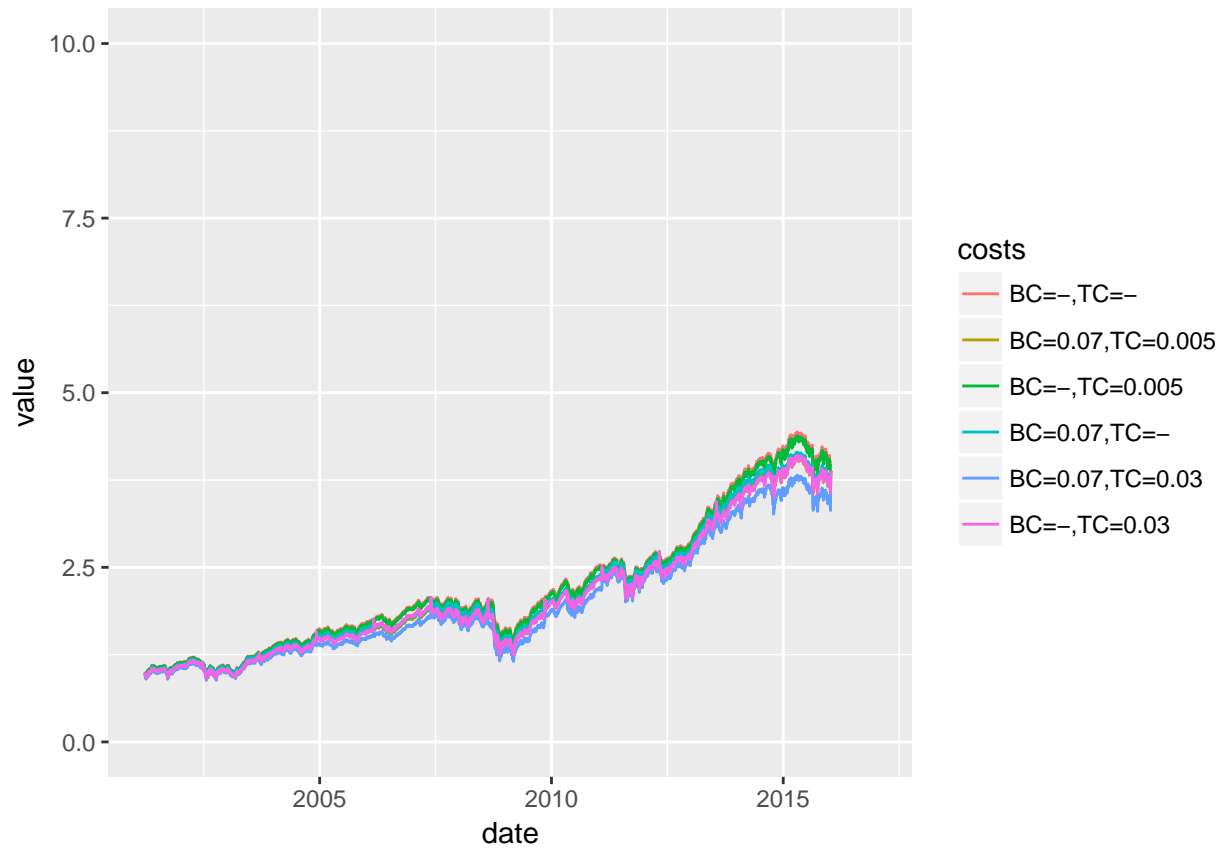
```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```



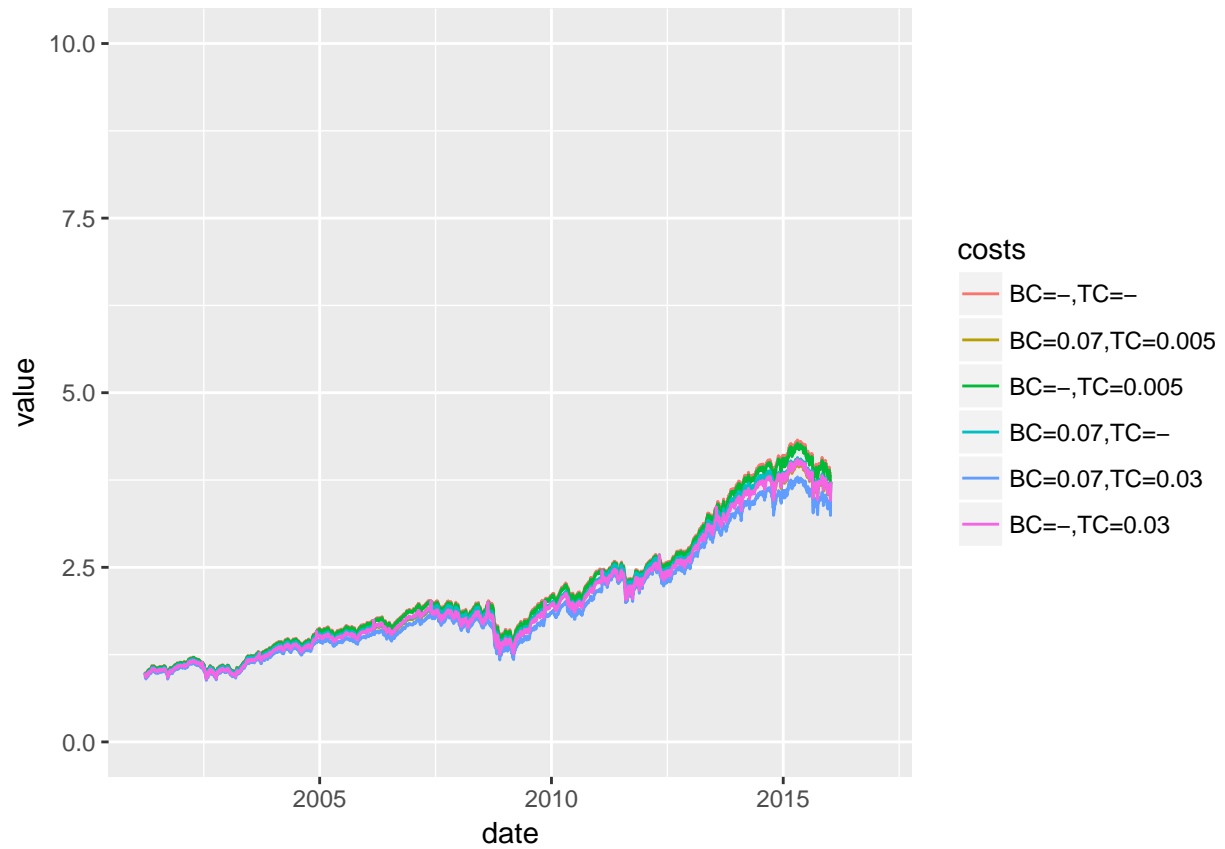
```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```



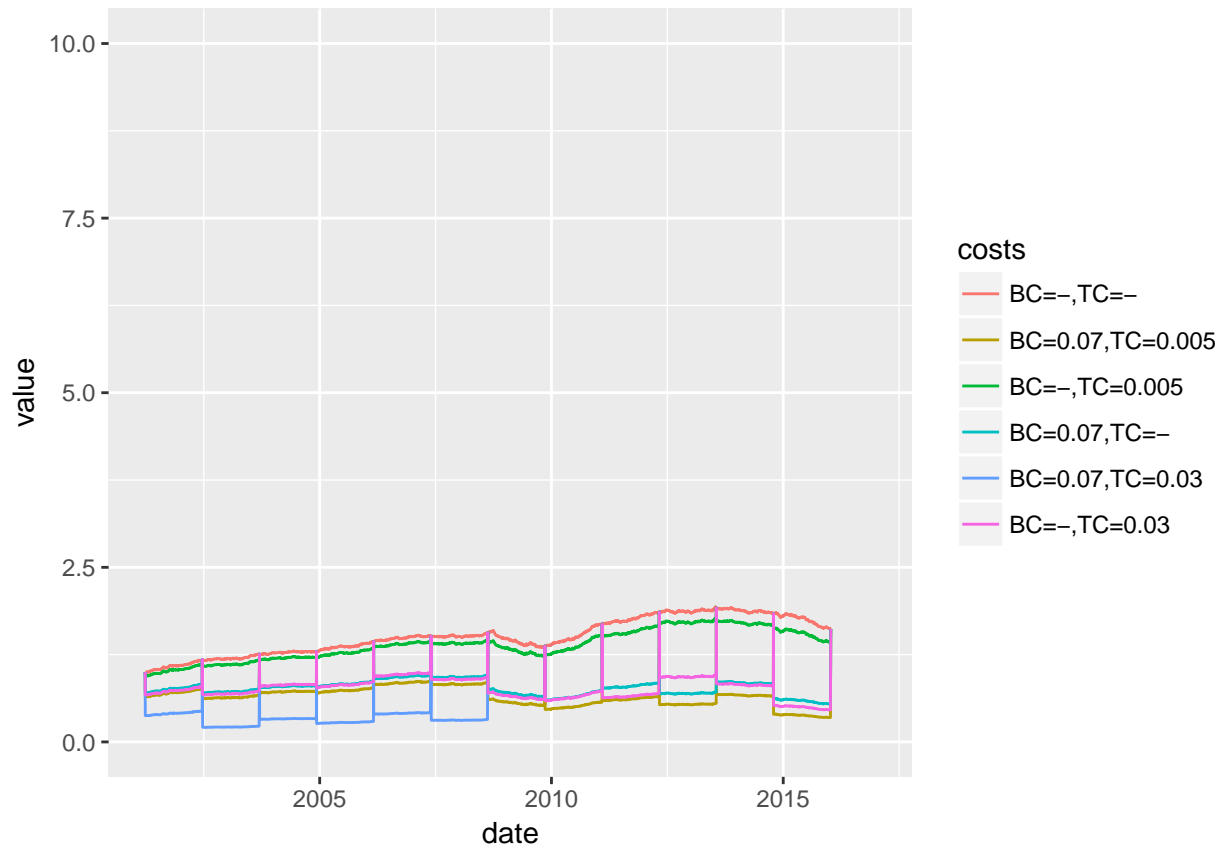
```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```



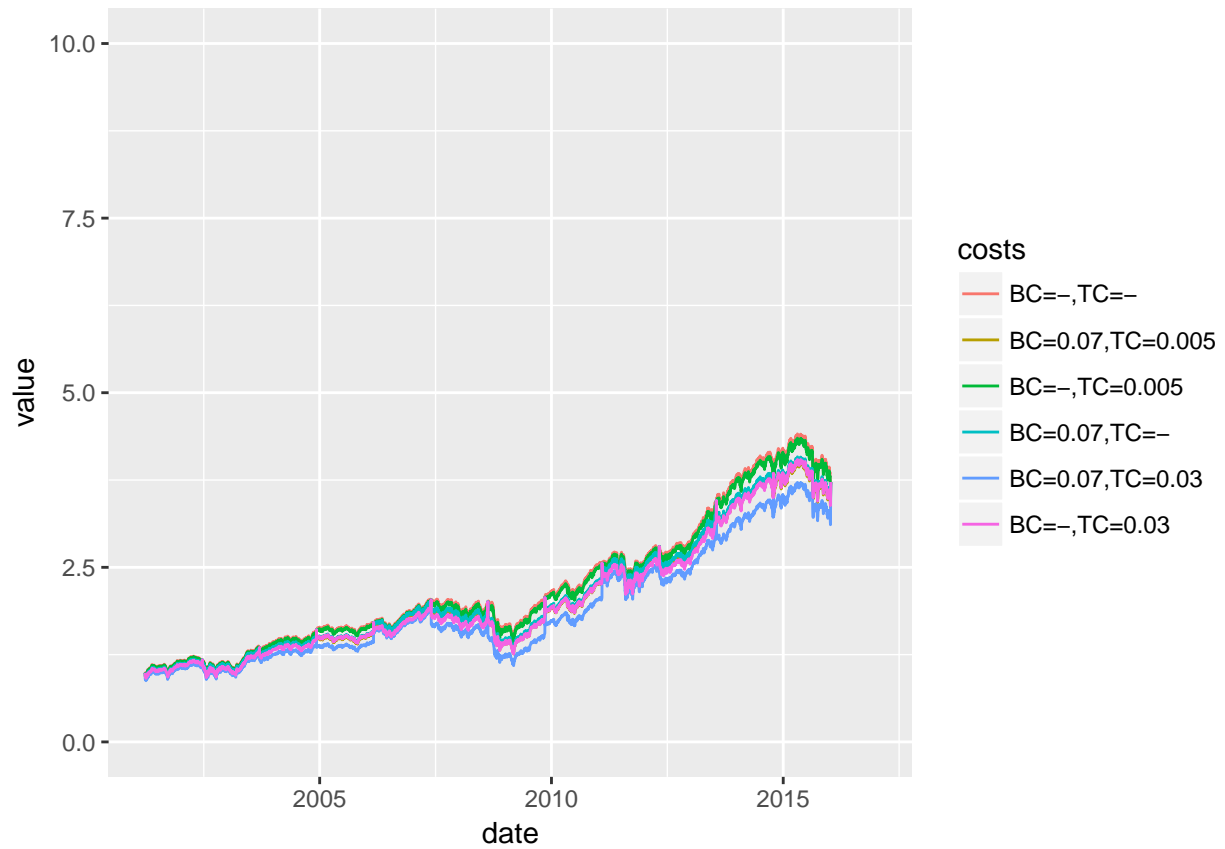
```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```



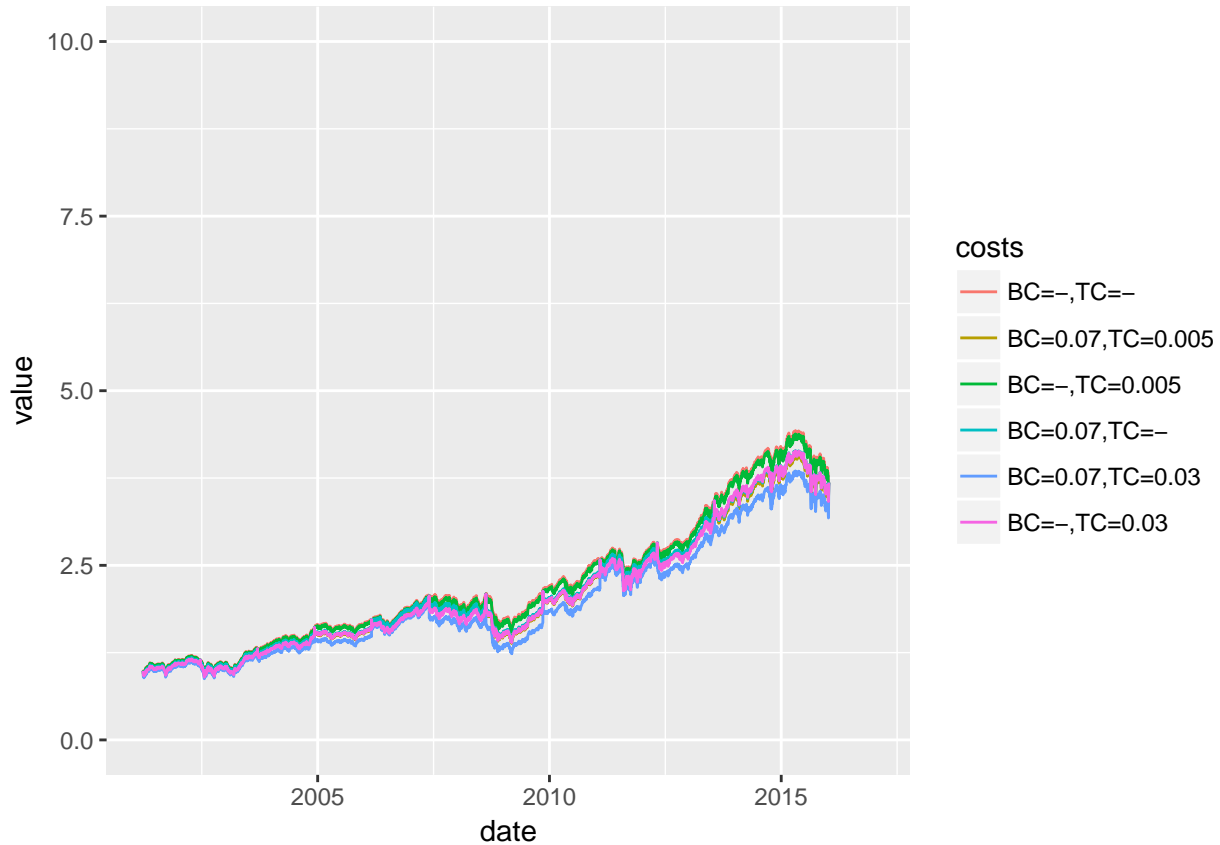
```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```



```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```

```
## Warning: Removed 1476 rows containing missing values (geom_path).
## Saving 6.5 x 4.5 in image
## Warning: Removed 1476 rows containing missing values (geom_path).
```



BC and TC adjusted return statistics

Adjusted Sharpe Ratio

Effects of borrowing costs (BC at 8% APR) and transaction costs (TC at 0.5% of total trades) on Sharpe ratio (risk free rate at 5% APR)

```
for (Nest in as.character(lookback)) {
  snm <- paste("shpadj", Nest, sep = "_")
  shpadj <- get(snm)
  shpadj <- subset(shpadj, relBC == 0.08 & relTC == 0.005)
  print(xtable(prepsbp(shpadj), digits = 3))
}
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:02 2017

	BC	TC	CCA	IPF
0_0_0.08_0.005			0.455	0.445
0_1_0.08_0.005		0.5\%	0.407	0.403
1_0_0.08_0.005	8\%		0.280	0.291
1_1_0.08_0.005	8\%	0.5\%	0.232	0.248

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:02 2017

	BC	TC	Sample	CCA	IPF
0_0_0.08_0.005			0.098	0.442	0.427
0_1_0.08_0.005		0.5\%	-0.844	0.385	0.377
1_0_0.08_0.005	8\%		-0.875	0.177	0.187
1_1_0.08_0.005	8\%	0.5\%	-0.876	0.121	0.138

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:02 2017

	BC	TC	Sample	CCA	IPF
0_0_0.08_0.005			-0.056	0.452	0.451
0_1_0.08_0.005		0.5\%	-0.818	0.370	0.383
1_0_0.08_0.005	8\%		-0.877	0.057	0.093
1_1_0.08_0.005	8\%	0.5\%	-0.877	-0.015	0.030

Effects of borrowing costs (at 8% APR) and transaction costs (at 3% of total trades) on Sharpe ratio (risk free rate at 5% APR)

```
for (Nest in as.character(lookback)) {
  snm <- paste("shpadj", Nest, sep = "")
  shpadj <- get(snm)
  shpadj <- subset(shpadj, relBC == 0.08 & relTC == 0.03)
  print(xtable(prepshp(shpadj), digits = 3))
}
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:02 2017

	BC	TC	CCA	IPF
0_0_0.08_0.03			0.455	0.445
0_1_0.08_0.03		3\%	0.167	0.189
1_0_0.08_0.03	8\%		0.280	0.291
1_1_0.08_0.03	8\%	3\%	0.008	0.044

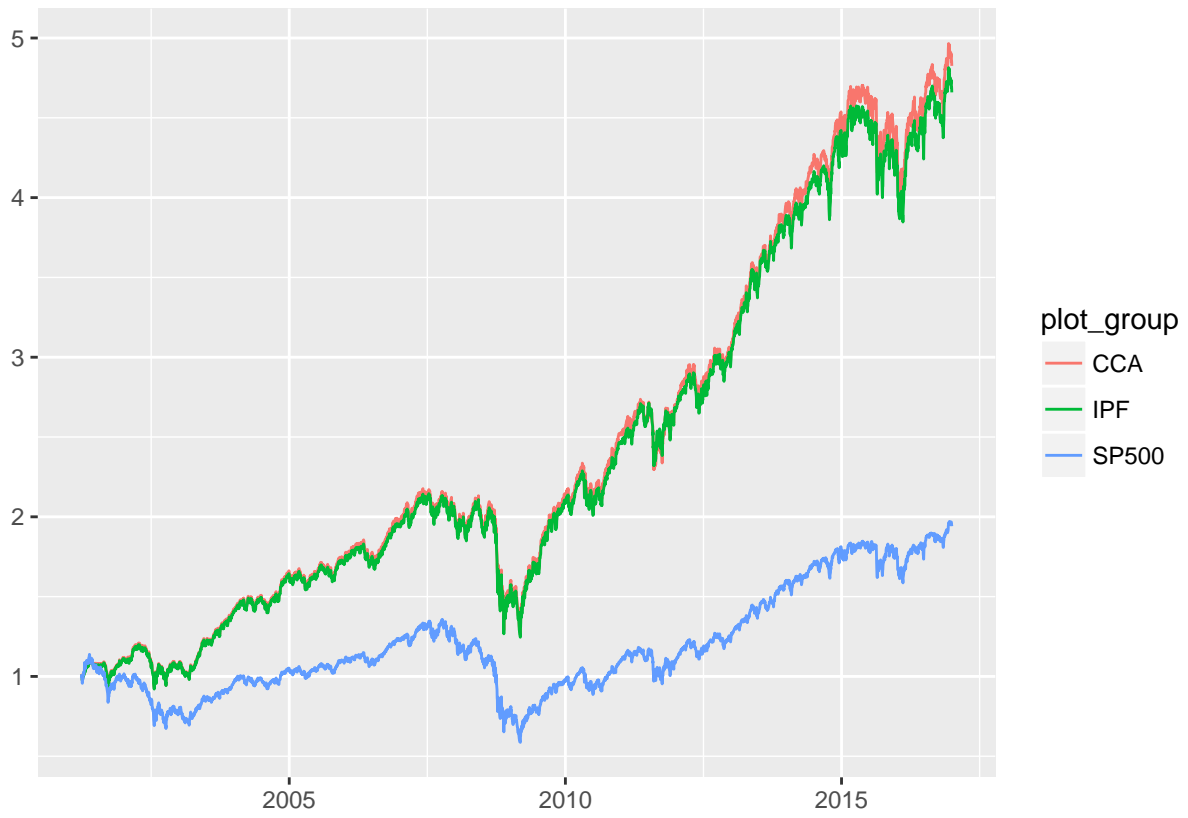
% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:02 2017

	BC	TC	Sample	CCA	IPF
0_0_0.08_0.03			0.098	0.442	0.427
0_1_0.08_0.03		3\%	-0.876	0.099	0.126
1_0_0.08_0.03	8\%		-0.875	0.177	0.187
1_1_0.08_0.03	8\%	3\%	-0.878	-0.124	-0.084

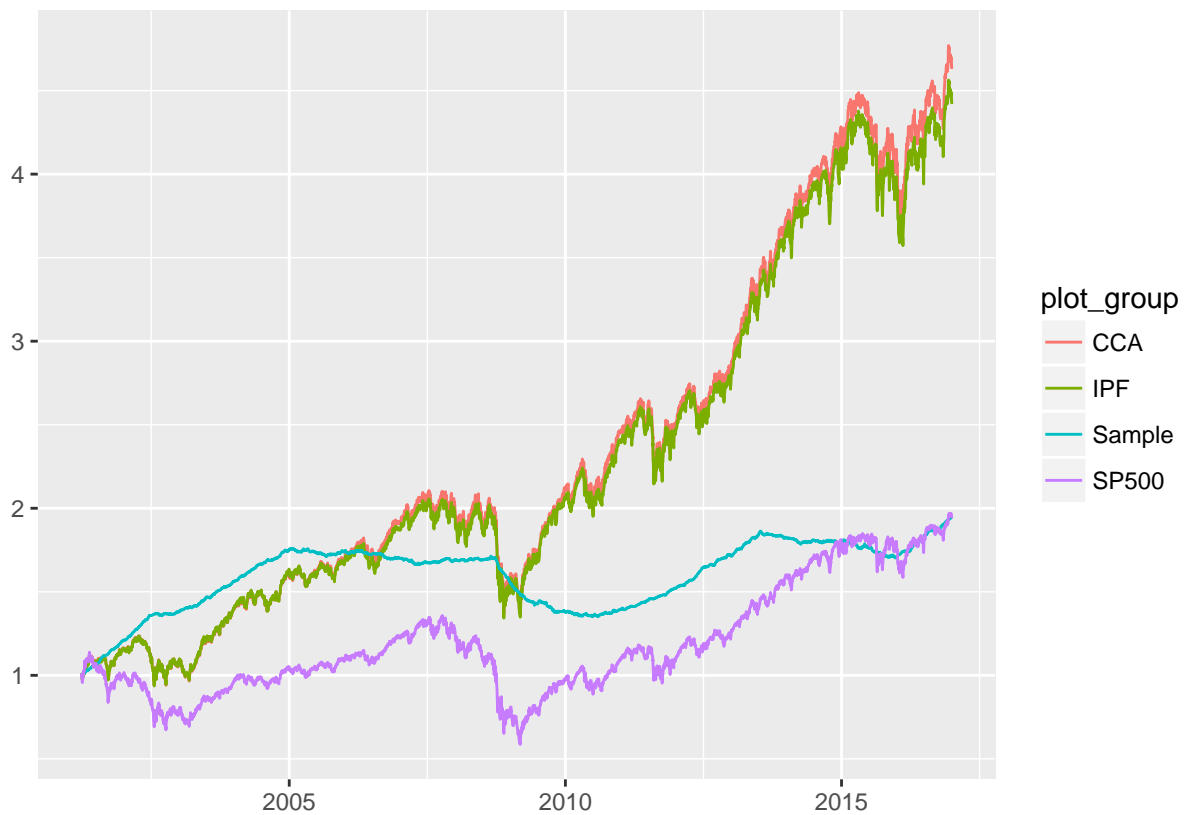
% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:02 2017

	BC	TC	Sample	CCA	IPF
0_0_0.08_0.03			-0.056	0.452	0.451
0_1_0.08_0.03		3\%	-0.875	-0.025	0.043
1_0_0.08_0.03	8\%		-0.877	0.057	0.093
1_1_0.08_0.03	8\%	3\%	-0.878	-0.290	-0.225

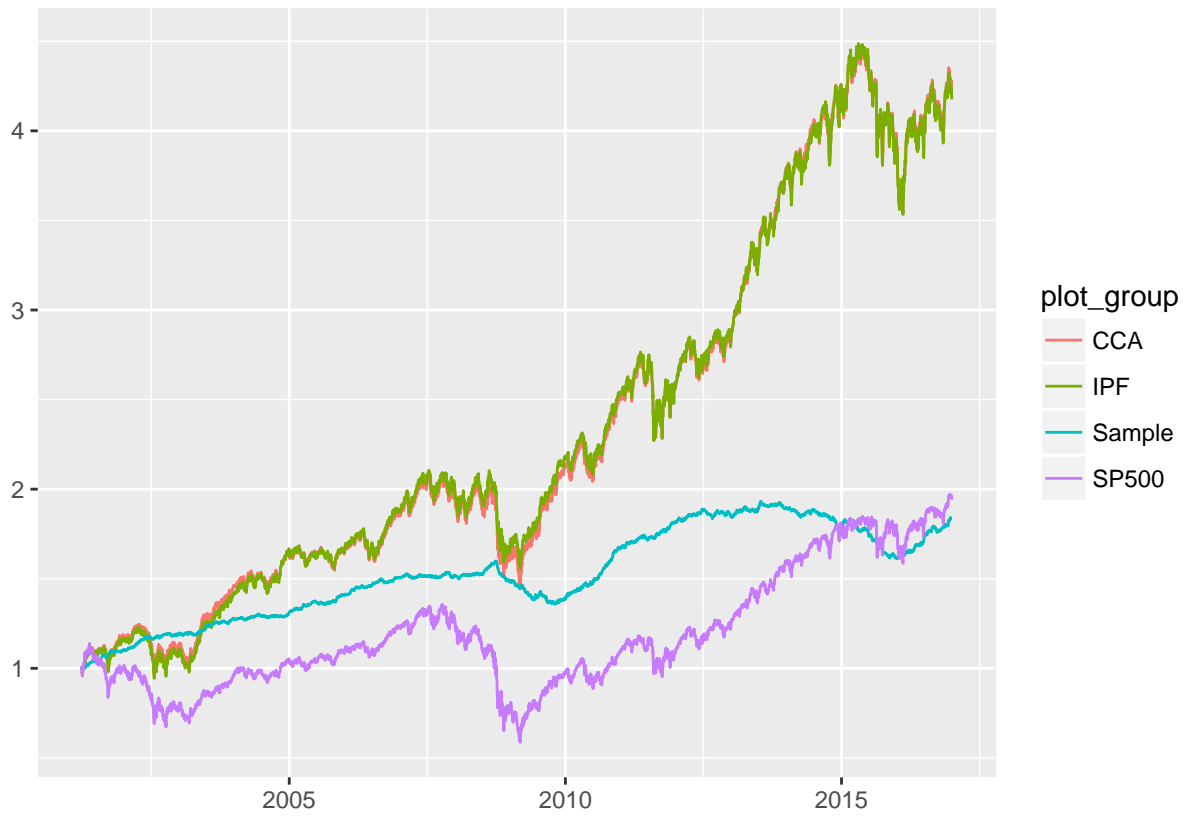
Saving 6.5 x 4.5 in image



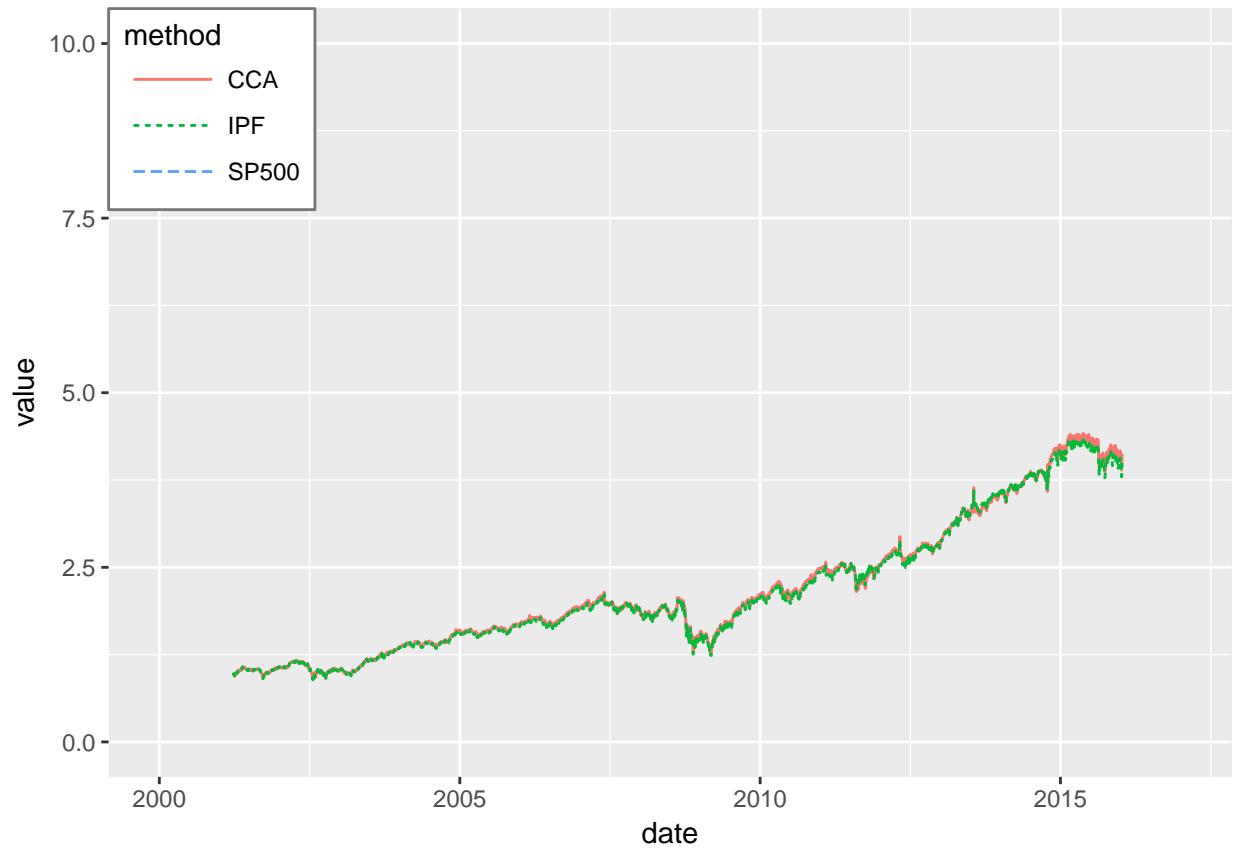
```
## Saving 6.5 x 4.5 in image
```



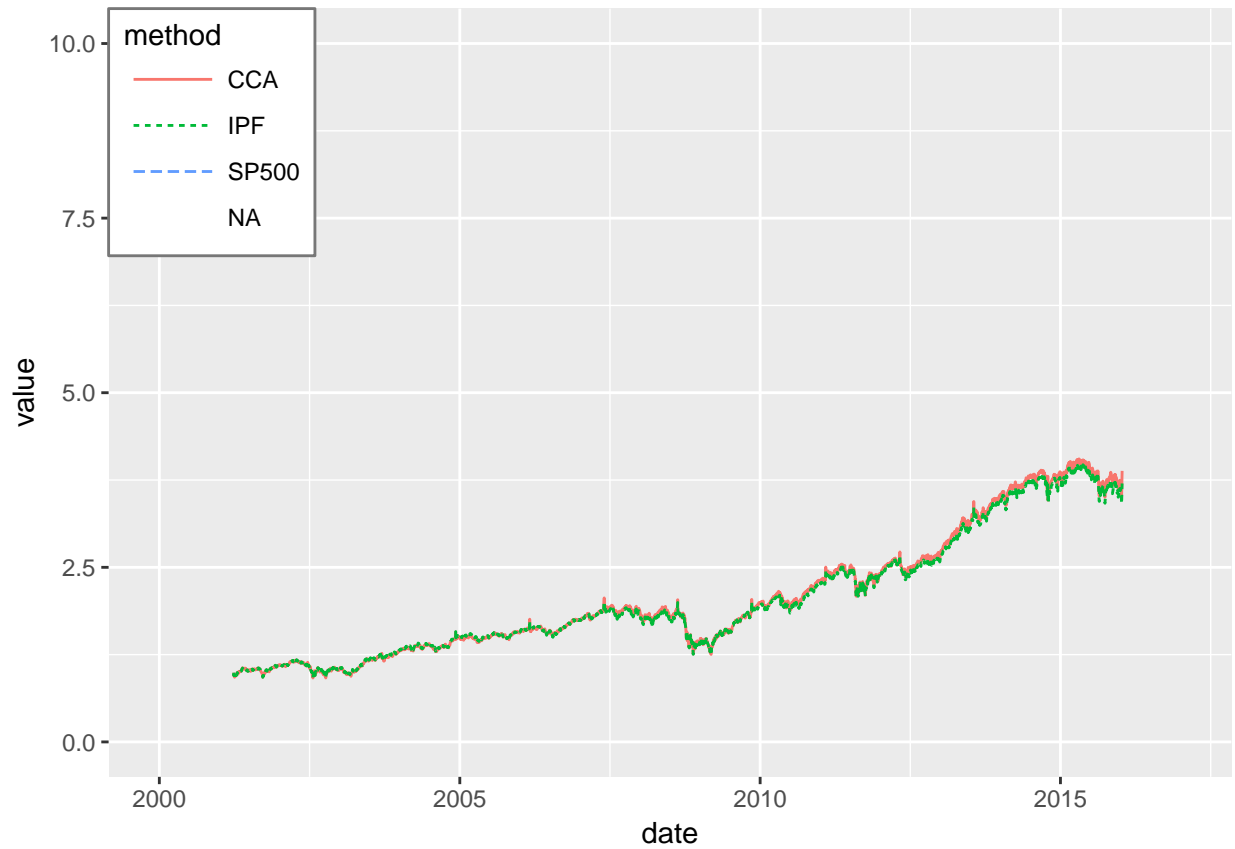
Saving 6.5 x 4.5 in image



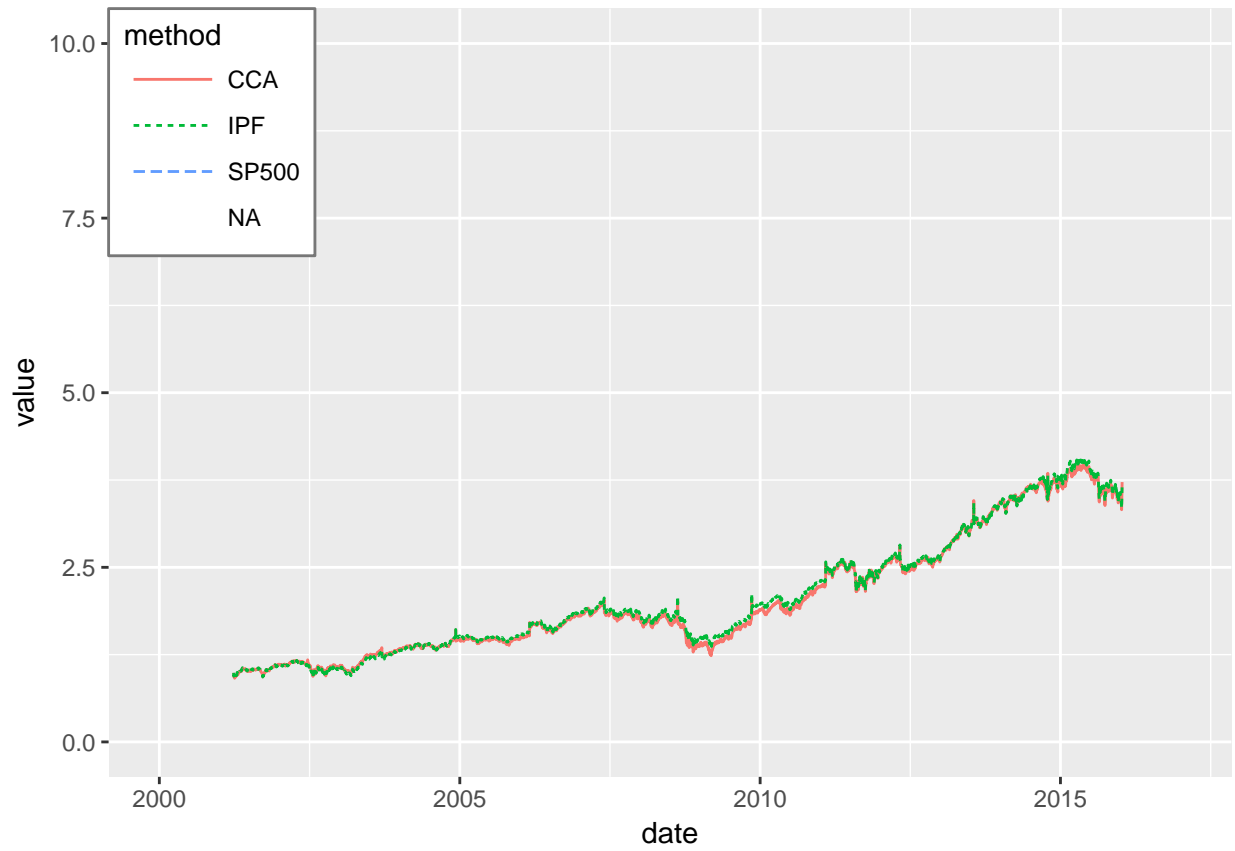
```
## Warning: Removed 1114 rows containing missing values (geom_path).  
## Saving 6.5 x 4.5 in image  
## Warning: Removed 1114 rows containing missing values (geom_path).
```



```
## Warning: Removed 1671 rows containing missing values (geom_path).  
## Saving 6.5 x 4.5 in image  
## Warning: Removed 1671 rows containing missing values (geom_path).
```

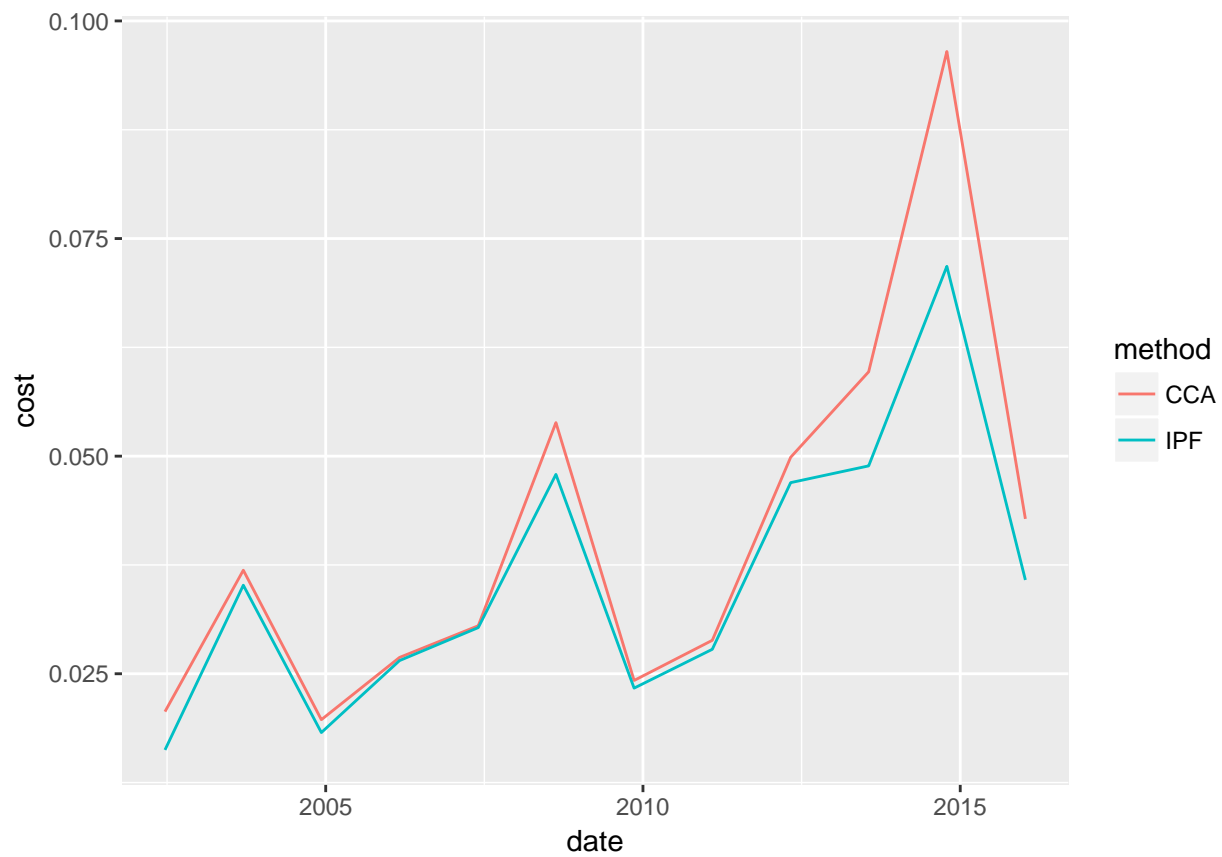


```
## Warning: Removed 1671 rows containing missing values (geom_path).  
## Saving 6.5 x 4.5 in image  
## Warning: Removed 1671 rows containing missing values (geom_path).
```

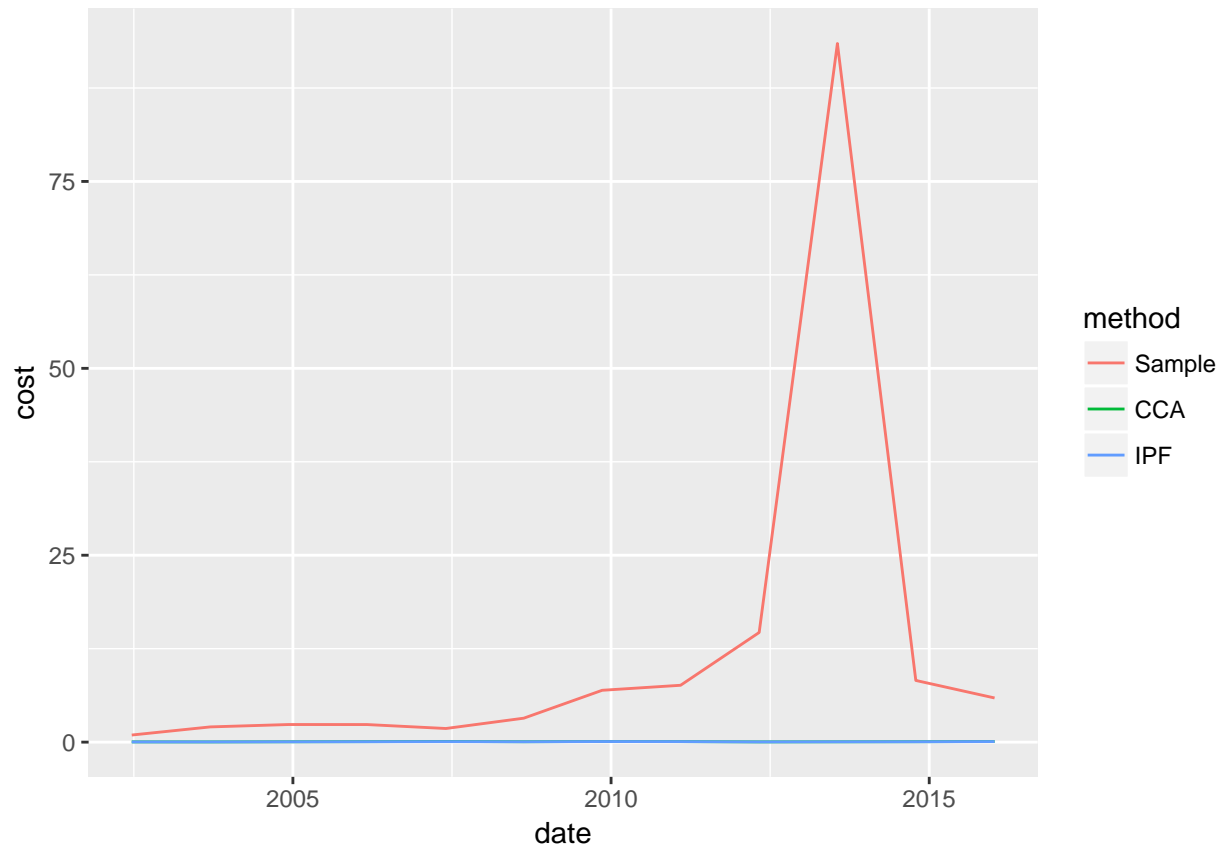



Trading costs

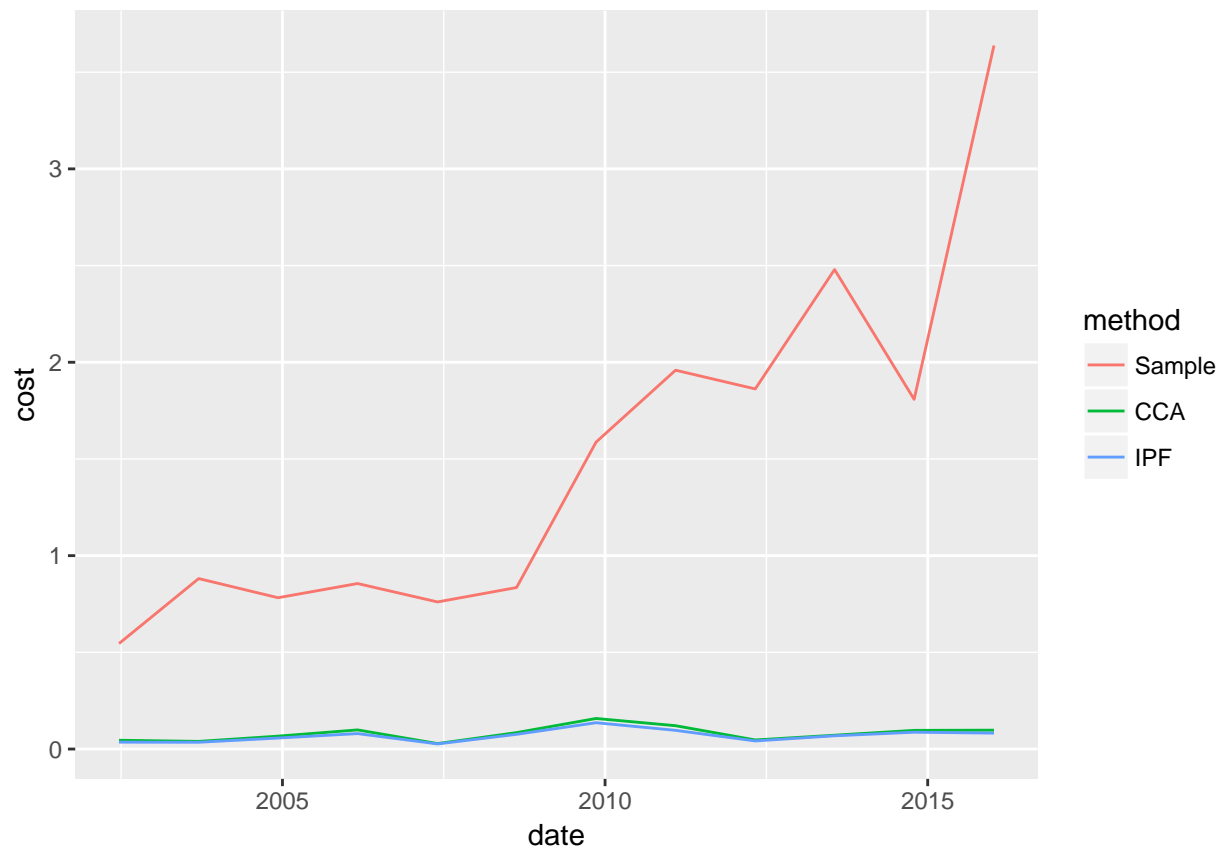
Saving 6.5 x 4.5 in image



Saving 6.5 x 4.5 in image



Saving 6.5 x 4.5 in image



```
xtable(meancost * 10000, digits = 3)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:08 2017

	Sample	CCA	IPF
375		408.674	357.462
450	124611.178	573.794	506.463
525	14995.421	795.697	685.095

```
xtable(sdcost * 10000, digits = 3)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Sat May 20 15:44:08 2017

	Sample	CCA	IPF
375		219.446	158.534
450	258018.489	223.128	179.468
525	9138.817	376.520	314.909